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THE DEVELOPMENT OF WAGE DISPERSION AND WAGE RIGIDITY IN FINLAND

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The development of wage dispersion and wage rigidity in Finland

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Abstract

This paper examines the development of wage dispersion and wage rigidity in Finland since mid-1990's. We show that the increase in between-firms variance dominated during late 1990's, but after that the overall increase in wage dispersion has occurred within-firms. This is different from many other countries where the increase in between-firms wage differences have explained (a large share of) the increase in overall wage variation. Second, we estimate parametric measures for downward nominal and real wage rigidities using the methods developed in the International Wage Flexibility Project (IWFP). Thereby we update these measures for Finland until 2013, when previously estimates have been available only until 2000. We find that micro-level real wage rigidity has remained high and nominal rigidity rose during the financial crisis. These rigidities together with low inflation have prevented real wage adjustment downwards particularly during recessions. Finally, we find that the primary margin to adjust wage costs in firms is the adjustment of employment, rather than other possible margins, such as hourly wages, overtime or regular working hours, or turnover of employees. Furthermore, firm-level wages are very sticky in the face of local employment shocks, and wage cuts are delayed and muted when employment declines, compared to wage growth.

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Contents

1. Introduction

The purpose of this study is to produce mainly descriptive information on a number of topics related to the development of wage dispersion and wage rigidity over time in the Finnish private sector. Finnish wage determination institutions have remained centralized in international comparison, although there has been increasing pressure towards more decentralized system, in particular from the employer side. The first goal of this paper is simply to document how the dispersion of individual wages has developed over time - is it stable given the unchanged institutions; or have the existing institutions allowed for increasing wage dispersion similar to other countries. We find that existing labour market institutions have not prevented wage differences from increasing, and the share of between-firm variance in Finland is within the range of other countries. However, the increase in the between-firms share of total variance stopped from increasing early 2000's. This is different from many other countries where the increase in between-firms wage differences have explained (a large share of) the increase in overall wage variation. The reasons for this difference are unclear, but it may be related to job polarization and routine biased technological change, which have made job characteristics gaining more importance relative to firm characteristics in wage determination.

The second main topic is the extent and change of wage rigidities over time. We first take a look at what the distribution of annual nominal wage changes for individuals look like? What is the proportion of wage freezes (zero changes) and negative changes in nominal wages. How large are nominal wage cuts when they occur? These are indicators for downward nominal wage rigidity (DNWR). Secondly, we examine indications for downward real wage rigidity (DRWR) or contract wage rigidity. How many wage changes are below (expected) inflation? What is the proportion of wage changes below a "generally accepted" wage change (measured by the change in the contract wage index)? How large are real wage cuts or negative deviations from the union bargained contract wage raise? Third, we produce estimates for downward nominal and real wage rigidity using the parametric model developed in the International Wage Flexibility Project (IWFP). The method is explained in detail in Dickens et. al (2006). Thereby, we update these wage rigidity measures for Finland for the period 1995-2013, when previously estimates have been available only for 1985-2000 in Böckerman et. al (2010). Our main findings are that overall wage growth has responded to higher unemployment during the financial crisis and real wage cuts have contributed to the wage restraint, but micro-level real wage rigidity has remained high and nominal rigidity rose during the crisis. These rigidities together with low inflation have prevented real wage adjustment downwards particularly during recessions.

The third main issue in this study is to examine what other possibilities there are for firms to adjust their labor costs when they face demand shocks. We do this by decomposing the changes in firm-level wage bill to changes in employment, changes in hours worked and hourly wages for continuing workers, and finally, the effects from the turnover of workers when incoming persons wages differ from outgoing persons wages (or working hours); see Fuss (2009) and Deelen (2016). Our main finding is that the bulk of the downward adjustment of wage costs in firms experiencing negative shocks has occurred through cuts in employment. Given the high level of downward wage rigidity above, the contribution of existing workers' wage growth is positive (no wage cuts) even in firms experiencing declining sales - wage growth is only 0.5%-points lower in these firms on average compared to firms with increasing sales. The entry-exit effects for hours and sometimes for wages are positive, so firms do not seem to use turnover strategically to cut the wage bill in the face of negative demand shocks. In addition, the overtime effects are small. To control for reverse causality or intervening third factor effects we use lagged change in profits as a Bad State indicator. We find that the contribution of employment on wage bill adjustment is smaller, but it is still the dominant factor, that varies between good and bad state firms. We also examine the adjustment of firm-level wages to firm-level employment shocks. Our regressions show that the local (firm-level) wage setting is very rigid and slow to adjust, particularly downwards.

2. Data

The analyses are based on the harmonized wage structure statistics (HWSS for short) of Statistics Finland for the years 1995-2013. The wage structure statistics are representative of the population for firms larger than five employees (when sampling weights are used), and it is harmonized across the years for differences in industry and occupation classifications and the construction of different wage concepts. It also matches the earnings of workers exactly with the employer firm, in contrast to some other data sources, which match annual earnings to the employer firm at the end of year (e.g. FLEED).

These data include four wage concepts or measures. First, there is the regular *hourly* wage for regular working time and the corresponding *monthly* earnings for *regular working time*. These include basic contractual wages as well as supplementary pay for shift work, working conditions and performance pay and bonuses paid regularly for regular hours worked and based on individual performance. The annual bonuses, often based on group performance or the profitability of the firm, are *not* included. Second, there are hourly wages and monthly earnings for *total working time*, which include also

overtime pay. Finally, monthly working time for regular time and total time are available, the difference being the overtime hours.

Due to some outlying observations, we trim the data by dropping persons whose hourly wages for regular working time are below the 0.1 percentile value or above the 99.9 percentile value each year (calculated for non-zero non-missing wages). After this we checked, that there were no outlying values for monthly earnings to require further trimming.

We deflate nominal values with the consumer price index (1951=100) to obtain corresponding consumption real wages and earnings. The contract wage index (1995=100) is obtained from the time series database (Astika) of Statistics Finland. We use the index for all forms of pay for the private sector[1]. Since the HWSS wage data is for the last quarter of each year we use the last (4^{th}) quarter values of the contract wage index each year to construct the average contract wage rise annually. We also examine producer real wages, which are obtained using the implicit price indices for two-digit industries from National Accounts (Astika) as deflators.

3. Dispersion of wages and wage changes

3.1. Distribution of wages and working time

We start by describing the development of a number of measures for the dispersion of wages or wage differences. We use the standard deviation of log wages/earnings as a general measures for dispersion. We measure standard deviations or variances of wages using natural logs to highlight the proportional wage differences that are more robust to extreme values in levels. Second, we use different percentile ratios to describe the wage differences in different parts of the distribution; for example the ratio of the 90^{th} percentile to the median and the 10^{th} percentile to the median to describe possibly different developments in the upper and lower parts of the distribution. All our measures are weighted by the sampling weights (to make them representative for the population) and by regular working time of the person. Thereby our results pertain to a randomly selected hour of work, rather than a randomly selected person.

[1] The Astika database does not include the contract wage index for the years 1995-1999. For these years we used contract wage rises from Marjanen (2002).

Figure 1. depicts the standard deviations for log hourly wages and monthly earnings. The standard deviations and their development over time for regular working time and for total working time are usually very similar. The dispersion is larger for earnings than hourly wages, because the latter captures also differences in working time across individuals. The rising trends for hourly wages and monthly earnings are quite similar in broad terms. The increase in the SD for hourly wages is about 4 pp (from 0.32 to 0.36) from 1995 to 2013, and 5 pp (from 0.35 to 0.41) for monthly earnings. The increase in dispersion is somewhat faster during the early years of 1995-2001 (recovery from the 1990's recession) than in later years. There may also be some further slowdown during the present crisis (after 2008/2009). The coefficient of variation, which accounts for the rising level of real wages, is virtually flat for the consumption real hourly wages and monthly earnings (not shown in figure).

Figure 2. depicts the development of P90/P50 and P10/P50 percentile ratios for hourly wages for regular time and monthly earnings for total time (we use only these two wage concepts in the future as the other two behave similarly to these as already shown by the standard deviations). The wage differences increase in a trend like manner both in the upper and lower parts of the distribution until years 2008 (upper) and 2010 (lower) when the changes level off. The P90/P50 ratio increases by about 13 pp for both hourly and monthly wages, and the P10/P50 ratio drops by about 4-5 pp. In relative terms, changes in the upper and lower parts are similar, about 7-8 percent increase in wage differences. Therefore, the wage differences as measured by the P90/P10 differential have widened by about 15 % from 1995 to late 2000's. However, during the last crisis years (from 2008-2010 onwards) this increase has leveled off, with no further increase in wage differentials as measured by the percentile ratios, although the standard deviations indicated some increase also during this period.

Figure 3. presents the development of the percentiles of the total monthly earnings (actual values in 2013 euros, not logs). The real wages have risen in all parts of the distribution above the 10th percentile. However, the 1st percentile of real earnings declined somewhat during the 1995-2001 period, but has risen somewhat since then, ending slightly lower in 2013 compared to 1995.

Figure 4. presents the ratio of the top 1% to the bottom 1%. It has increased considerably from 6 in 1995 to around 8.5 in 2009-2013. Most of the increase occurred during the 1995-2001 period, with slower increase in 2001-2009, and then leveling off. The increase is due to the increase in highest earnings and a relative constancy of the lowest earnings.

Figure 5. shows the development of average working hours per month and their standard deviation. Working hours per month have dropped by about two hours from 1995 to 2013, primarily during two phases in the last years of the 1990's and abruptly during the beginning of the present crisis. At the

same time, the dispersion of working time has increased. This would seem to imply that the working time for those working low hours has dropped more than for those working long hours. The average number of overtime hours has been quite steadily two hours (the difference between total and regular hours), with some decline during the present crisis.

Figure 6. presents a decomposition of wages (monthly earnings) into within firms variance and between firms variance components. The decomposition is obtained using the formula in Davis and Haltiwanger (1991, fn. 23). The between firms component is the hours weighted variance of average firm wages, and the within firms component is the hours weighted average of variances within each firm. Many countries have experienced increases in the between firm variance that explains (almost) all of the increase in overall variance of wages; see e.g. Barth et. al (2014) and Song et. al (2015). Increasing between firm component in the variation of wages may reflect two factors. First, it could be that productivity and/or rent-sharing differences between firms are increasing. Second, it could be that the assortative matching of high skilled workers to high wage firms is increasing.[2] Card et.al (2013) find for Germany, that both have about an equal effect on the rise in overall wage inequality (a quarter and a third respectively), with the person-specific component having an additional somewhat larger effect (40%). For Finland we find, first, that the within firms variance is larger than the between firms variance. Comparison with other countries is difficult, because wage measures and periods differ, but it seems that the between firms share in Finland is smaller than in USA and UK but larger than in Sweden[3]. Therefore, the between firms variation of wages in Finland is well within the range of other countries, being less than in the most flexible countries but higher than in late 90's Sweden. Second, both variances have increased, but the increase in between firms variance has levelled off, whereas within firms variance has continued to increase. As a results, the between firms share of total variance increased by 6 pp (from 0.36 to 0.42) during 1995-2001, but has remained more or less flat since then, with some small decline since 2008. During late 1990's, the increase in between firms variance dominated the within firms increase, but during 2000's the overall increase in wage dispersion has occurred within firms, rather than between firms. This implies that during the last decade the increase in wage dispersion has been more related to characteristics of individuals (e.g. skill bias), or to the characteristics of their jobs (polarization), rather than characteristics of their

[2] A third possible explanation is that the variation in monopsony power is increasing between firms. See Council of Economic Advisers (2016).

[3] Results in Davis and Haltiwanger (1991) Table 2 imply a between firms share of over 60% (production and non-production combined) in US during 1975-1986. Faggio et.al. (2007) Figure 8 shows that the between share in UK increased from somewhat below 50% to over 50% during the period 1984-1999. Nordström Skans et. al. (2009) Fig. 7.8 shows an increase in between plants share in the Swedish private corporate sector from 20% in 1985 to 30% in 2000.

employer firms or assortative matching. In this respect, the development in Finland seems to differ from that in many other countries during recent years (decade). It is hard to say why Finland is different in this respect. It is unlikely to relate only to labour market institutions, because the rising trend stopped in the early 2000's, and if anything, there has been pressure from the employer side towards more decentralized bargaining since then, which should have increased the between firms variation in wages.

3.2.Dispersion and mean of wage changes

Figure 7a. shows the development of average wage increases for different wage measures. The increase in real hourly wages has been around 3% annually, except during the 2010's when the increases have dropped below 2 %. Thus, there has been some real wage moderation during the crisis years. The wage increases for total monthly earnings have been higher, by almost 1 pp, for all years. Since the average working hours have declined, this difference must be related to the increasing dispersion in working time, and its correlation with wage level, in such a manner that total earnings rise more than hourly wages. Figure 7b. shows that there is no systematic difference in the overall level of consumption and producer real wage growth, although they may differ considerably in individual years.

Figure 8. shows that there is no significant trend in the dispersion of changes in hourly wages for regular working time, but there is some trend like increase in the dispersion for changes in total monthly earnings. This difference is likely to reflect the increasing dispersion of working time noted above. Figure 9. presents a decomposition of the total variance of wage changes into within and between components similar to wage levels above. These are for monthly earnings for total working time. The trends for hourly wages for regular working time are similar (not shown in the figure), but the level of variances is lower, about half of those in Figure 9. In contrast to wage levels, there are no notable trends in these components. If anything, there is some increase in both components before the present crisis, but then a decline back during the crisis years (2010-2013). The between firms share of total variance is much smaller (20-25%) for wage changes compared to wage levels. This is lower than Nordström Skans et. al. (2009) report for Sweden[4]. This is as expected if the centralized wage setting institutions in Finland decrease variation in firm level wage changes and thereby keeps

[4] Nordström Skans et. al. (2009) report in Table 7.6 that the between plans SD of wage changes in Sweden was *higher* than the within plants SD over the period 1986-2000 implying a between share of over 50%.

existing firm wage differences intact. The decline in between firms share during the crisis is likely to reflect the increase in wage setting co-ordination during the crisis years.

Overall, perhaps in contrast to common beliefs and some media views, wage dispersion (differences) has increased quite substantially from mid 90's until the present crisis. However, during the financial crisis, dispersion has been more or less constant or growing only slowly depending on the measure used. During late 1990's, the between firms share of wage variance increased, but during 2000's the overall increase in wage dispersion has occurred within firms, rather than between firms. The between firms variation of wages in Finland is not particularly small, and the break in the increasing trend seems difficult to explain simply by bargaining institutions. The relatively small share of between firms variation in wage growth may however reflect small local bargaining element in Finland.

4. Incidence of negative and zero wage changes

4.1. Annual wage changes

In this section, we report the incidence and size of negative wage changes, as well as the size of the zero spike. We report these for nominal wage changes, real consumption and real producer wage changes and the deviations of nominal wage changes from the contract wage rise as measured by the change in contract wage index.

Table 1 and Figure 10 present averages of these across all years 1996-2013. The numbers are for annual changes for continuers, i.e. persons who work for the same employer in the same occupation in two consecutive years following the practice of IWFP protocol for estimation of wage rigidities below. If a person changes employers, or the job she performs within the same employer firm, there are no restrictions on the change of her wage or earnings. The first observation is that the results are virtually similar for all age groups and for the prime aged, 25 to 55 years old. Therefore, we concentrate on the results for the prime aged since the parametric rigidity results below are for this age group.

The share of zero change (in practice a very narrow range around zero) is larger for nominal wages than for real wages or the deviations from contract raise. The average zero spike is 2.8% for nominal hourly wages, and 4.3% for full time monthly earnings. The zero share for contract deviations is somewhat larger than for real wages, which is natural as the "normal" annual wage change is

presumed to be the annual contracted wage raise, rather than inflation. However, the share of exact contract wage raises is quite small at 1.6% for hourly wages (for all workers with an observed hourly wage) and 2.3% for monthly earnings (for full time monthly paid). For producer real wages the zero spike is extremely small. This reflects the fact that price inflation varies across firms, but wage setting is more co-ordinated, so that there is less bunching of producer real wage changes to one particular number. Note, that the definition of zero change applied here is quite strict, as the contacted wage raises vary across industries and sectors, but similar to nominal spike we use a narrow range around the average of these as captured by the change in overall contract wage index. Widening the range would show more concentration to the contract raise and inflation, as indicated by histograms in the next section.

The shares of negative nominal or real wage changes on the other hand are non-negligible. About a third of continuing prime aged workers experience an hourly wage change that is smaller than the contract wage raise (34.9%), or experience a real wage cut (29.7%). About 16% experience a nominal wage cut. For producer real wages the share of wage cuts is largest at 35.9%. For monthly earning corresponding shares are a few percentage points smaller than for hourly wages. In addition, the means of these wage cuts are quite large. The largest mean cuts of almost -8% are for the nominal wages. The average wage cuts for hourly real consumption and producer wages were between -5% and -6%, and for monthly earnings about -4% to -5%. The deviations from contract rises averaged from -3% to -5% depending on the wage measure. The smaller mean for real cuts is due to a higher concentration of real cuts close to zero (nominal changes positive but below inflation) than for nominal cuts.

Although the average share of zero nominal changes is quite small, the zero spike has been substantial in some individual years; see figure 11. It is notable that zero spikes concentrate on years of economic recessions. The zero spike in 1997 is due to the postponement of contract wage rises in 1997 to the next year as a response to an economic slowdown that started in 1996. The spikes in 2007 and after are likely to relate to the wage moderation during the financial crisis, but they may partly also reflect the timing of bargaining. Both in 2007 and in 2009 some industries reached a contract only early next year, so there may have not been any contractual wage increases during 2007 or 2009 in these industries. If the next year raises compensated for this, the wage freezes were temporary and simply reflected the timing of contracts. If there was no compensation, they were true wage freezes. Some part of the zero spike in 2011 may also reflect similar factors, because some of the ongoing industry level contracts lasted until the spring of 2012, so there may have not been contractual wage raises in

2011 in these industries, although the Framework agreement for 2011-2013 was centralized.[5] During normal times, zero nominal spikes are essentially non-existent. On the other hand, the shares and average sizes of nominal wage cuts are quite stable over time, with some tendency for the mean of nominal cuts increasing in absolute terms (see Figure 11). There are less nominal cuts in monthly earnings for full time monthly paid workers, than for hourly wages for all (including part-time workers and both hourly paid and monthly paid), but their mean sizes are similar.

Figure 12 presents the share of real consumption wage cuts and their mean in each year. It is noteworthy that the share of real wage cuts has been higher than normal during the crisis years 2008, 2011 and 2012. The low share of real wage cuts in 2009-2010 is due to the very low inflation during these years (0 in 2009 and 1.2% in 2010). In 2009 the share of real wage freezes was particularly high, instead of real wage cuts, because there were nominal freezes and also inflation was zero. When inflation picked up in 2011-2012, nominal wages did not follow, and 50-60% of workers experienced real wage cuts. However, the mean of real wage cuts declines during the financial crisis. This is probably due to two effects: in some crisis years inflation is low (2009, 2010, 2013), which tends to make real cuts smaller. But in 2011 and 2012 inflation is relatively high, so this alone cannot be the reason. Another factor is that there are more small real cuts, because contract raises in 2010, 2011 and 2013 were just below inflation. Therefore, there is clearly some indication of increasing real wage moderation during the years of financial crisis, because the share of real wage cuts increases and the contract wage rises decline below inflation. On the other hand, the rising downward nominal wage rigidity seems to limit the size of these wage cuts. If nominal wage freeze limits the nominal cuts, then the size of inflation limits the size of real wage cuts. Therefore, low inflation during the crisis years is one factor limiting the downward adjustment of real wages.

Figure 13 contrasts the real consumption and producer wage cuts. There have been somewhat more producer real wage cuts over the years, except during the last crisis years in 2010-2013. The higher share reflects the fact that for some firms (industries) the producer prices rise more than the overall consumer prices, leading to declines in real producer wages although consumption real wages are rising. During the crisis years this difference disappears, which seems to imply either that the variation in industry price inflation has declined, or there is larger than usual number of industries that experience lower price inflation than in consumer prices (or even price declines). This leads to positive producer real wage growth if nominal wages grow more than the producer price (or if they

[5] The information regarding the timing of contracts is from the Annual Reports of the Employer Association.

decline less than the producer price), even though consumption real wage is declining. There is no systematic difference in the average size of producer real wage cuts and consumption real wages cuts.

Figures 14 and 15 present the development over the years of the deviations from contract wage rise. They mimic to some extent the development for real wages. The share of negative deviations and their average size increase to some extent during the financial crisis. Especially in 2007-2011, some 40% of workers experienced wage changes below the contract wage rise. During the last two years 2012-2013, these measures seem to drop back again. A larger moderation in wage contracts occurred after our data period. In 2014-2015 contract wage rises were about 0.6% each year. Nevertheless, our numbers do indicate that there is also some increase in wage moderation, due to individual or local wage setting during the crisis years, which produces smaller wage growth for some workers than the contract wage raises.

4.2. Real wage cuts over 3-year periods

It is likely that annual wage changes include measurement error, so that the share of wage cuts is overestimated. Annual changes may also overestimate the size of wage cuts if the cuts are transitory, i.e. cuts this year are compensated by raises next year. On the other hand, annual wage changes may underestimate the size of longer-term wage cuts, if the same persons are subject to a series of wage cuts in consecutive years. To decrease these kinds of effects on our results, we calculate the share and size of real wage cuts also over three year periods. Such longer differences are less prone to transitory wage changes, and better capture the cumulative effects over time. The measurement error effect should also be smaller as the true wage change over three years is larger, so the noise to signal ratio declines.

Figure 16 shows that the share of real wage cuts over three years starts to rise after mid 2000's after some decline before that. The share rises to about 40% for continuing workers in 2012-2013, which is four times the share in mid 2000's. The second panel shows that at the same time the average of real wage cuts drops due to the reasons discussed above for annual cuts. Figure 16 includes comparable data for job switchers, who change either employer firms or occupation within the same firm (or both). Although the share of real wage cuts are similar for continuers and switchers, the average size of the cuts is larger for switchers compared to continuers. Thus, from persons who

experience a real wage cut, those who switch jobs lose more than those who keep their jobs. The average difference between switchers and continuers is 3-4%p.

The last panel of Figure 16 shows the average real wage growth for all workers over the 3-year periods. These peak around 2005, and turn to a decline after increasing before that. The real wage growth for job switchers is larger than for those continuing in the same job. This implies that, in general, job switchers move towards better paying jobs. However, the difference for those experiencing real wage cuts was opposite as noted above. Thus, job switches that lead to real wage cuts are likely to be forced rather than voluntary job changes. The decline in overall real wage growth over three year periods is considerable; from 10 % in 2005 to 2 % in 2013 for hourly wages of continuers, and 12% to 4% for monthly earnings of continuers. This implies considerable real wage moderation during the financial crisis and it seems that the real wage cuts or slow wage growth cumulate to some extent to the same persons over time.

5. Parametric estimates for downward nominal and real wage rigidity

In this section, we apply the methodology developed in the International Wage Flexibility Project (IWFP) to obtain parametric estimates of downward nominal and real wage rigidity. The methodology is explained in Dickens et. al. (2006). It has been applied to Finnish data earlier in Böckerman et. al. (2010) for the years 1986-2000. They used the original Employer association data separately for manufacturing blue-collar workers, manufacturing white-collar workers and the service sector workers. The present HWSS data is based on the same raw data, but Statistics Finland has harmonized them across sectors and years. Therefore, our results are not fully comparable with the earlier ones, but we present some comparisons to obtain a rough picture of possible similarities and/or differences over time.

The IWFP methodology assumes that there is measurement error in the observed wages. The first step in the methodology is to estimate the true wage change distribution using a histogram consisting of 75 bins of 1 %-point length and a Zero change bin (in practice a very narrow range around zero). The second step is to estimate the downward nominal and real wage rigidities. The definition of downward real wage rigidity (DRWR) is based on the idea that some persons obtain wage changes according to the expected rate of inflation (constant real wage) whereas they would have obtained wage changes below the expected rate of inflation (a real wage cut) without downward real wage

rigidity. The amount of downward real wage rigidity is estimated by comparing the true wage change distribution to the notional wage change distribution that is not affected by real or nominal wage rigidities. Because the expected rate of inflation varies across persons, its mean and variance each year are also estimated parameters within the protocol. The estimated real wage rigidity gives the estimated proportion of persons that are affected by real wage rigidity of those persons that are potentially subject to real wage rigidity. The downward nominal wage rigidity (DNWR) is observed for persons who experience a nominal wage freeze when they would have experienced a nominal wage cut without nominal rigidity. The IWFP protocol estimate for downward nominal wage rigidity is the proportion of persons affected by nominal rigidity of those persons who are potentially subject to nominal rigidity and who are not affected by real rigidity. The rigidity measures therefore vary between 0 (no one is affected by rigidity) to 1 (all potentially subject to rigidity are affected by it). It is also possible to calculate a "total" rigidity measure as r + (1-r)*n, which reflects the proportion of persons who are affected either by real of nominal wage rigidity.

Figure 17 presents three different histograms for wage change distributions for each year. First is for the observed wage changes, second for the estimated true wage changes, and the third for the wage changes based on the parametric model that captures the nominal and real wage rigidities. The mean of the estimated expected inflation is also presented (as the yellow bar) to visually inspect how real wage rigidity is affecting the distributions. It is notable that in many years the wage changes pile up to the bin (1 %-point interval) that also includes the expected inflation, whereas there are much less observations to the left of this bin compared to the right of it. That is there is "missing mass" below the expected inflation rate, which makes the wage change distribution asymmetric (or skewed). This is a visual mark of downward real wage rigidity. In some years, the wage changes pile above the expected inflation rate. This reflects the effects of wage bargaining, where the contract wage increase has been set above the expected inflation rate to reward workers for the increasing productivity. That is, in such years, the majority of persons get real wage rises that reflect productivity growth. The IWFP protocol is able to capture this as real wage rigidity to the extent that the contract peak is not too far above the expected inflation, because the protocol allows for some variation in the expected inflation rate. Finally, in one year (1997) the observations pile up to the zero bin, whereas expected inflation is somewhat above it. The IWFP protocol may capture also this as real wage rigidity due to the distribution of expected inflation in the model, as inflation was close to 1% in 1996-1997. The zero spike in 1997 is due to the postponement of contract wage rises in 1997 to the next year as a response to an economic slowdown that started in 1996. Therefore, the wage freeze is likely to reflect downward nominal rigidity, but it may become measured as real rigidity due to the features of the

estimation protocol and the fact that (expected) inflation was low in this year. However, when inflation is low, the nominal and real wage rigidities are essentially indistinguishable.

In general, a spike at the zero bin and missing mass below it is a visual marker for downward nominal wage rigidity. It is notable that from 1996 onwards until 2007 there are no spikes at zero (apart from 1997 for the reasons explained above). After that year, we observe notable zero spikes also for 2009, 2011 and 2013. Overall, it therefore seems, based on the visual inspection of wage change histograms that during normal years, real wage rigidity characterizes wage determination, but there is no nominal wage rigidity. This is natural, as during normal times there is usually no need for nominal wage cuts for the majority of workers. However, during an economic downswing, nominal wage rigidity arises, as indicated by the years of financial crisis from 2009 onwards.

In figure 18 we attempt to summarize the effect of real wage rigidity on wage changes for all years. Here we use the observed wage changes and the actual observed inflation (rather than the estimated wage changes and the estimated expected inflation as above). We first center the wage change histogram in each year on the bin that includes the observed inflation rate (so this becomes the zero bin). We then average the histogram across all years 1996-2013. The average histogram centered on inflation reflects real wage rigidity if the mass piles around inflation (zero bin here) and there is missing mass below it, just like in annual histograms. There are clear indications of DRWR, but the spike at inflation and missing mass below are not as sharp as in annual figures. This reflects the fact that the bite of DRWR varies across years and in some years the spike of wage changes is further above the inflation and sometimes even below inflation. However, the figure is clearly consistent with DRWR.

The right hand panel in figure 18 repeats the averaging over the years, but using the average contract wage increase each year instead of inflation. As expected, we find that the spike at the contract wage rise is larger than at inflation. This is expected, if contract wage rises are in general binding and the wage drift element is not exceedingly large. The importance of contract wage rises in shaping the wage change histogram might be called contract wage rigidity.

Figure 19 and 20 present the estimated DRWR and DNWR for each year. These figures also include comparable measures for an earlier period (1986-2000) from Böckerman et.al. (2010). We use the measures for manufacturing blue collar workers for the earlier period as they were estimated using hourly wages for regular working time, similar to the ones we have estimated now for the period 1996-2013. The difference is that our present HWSS data includes more sectors that just manufacturing and we include in our estimations all workers who have an observed value for hourly

wage for regular working time in the HWSS data. That is we include both hourly paid and monthly paid in all sectors, as long as HWSS includes a value for the hourly wage for the person. However, the sample is otherwise restricted in two ways. First, only persons who remain in the same firm and in the same occupation in the two consecutive years are included in the estimation of rigidity measures. As noted above, job changers provide no information about the rigidity or flexibility of wage determination, and therefore they are excluded from the estimations. Second, the sample is restricted to prime aged workers, aged 25-55, similar to the estimations in the IWFP. The wages of labor market entrants and those closing to the retirement age may be affected by factors that do not reflect the general flexibility/rigidity of wage setting for prime aged workers.

Real wage rigidity varies between 0.6 and 1 annually, averaging about 0.8 over the years. For some individual years, like the recession years 1992-1993 and later in 2003 and 2007 (when mean wage growth substantially exceeds expected inflation), the real rigidity has dropped to 0.15-0.35. Otherwise, DRWR has been quite stable over time around an average of some 0.8. That is 80 % of workers potentially subject to DRWR, have been affected by it. It should be noted, that this does not mean that 80 % of all workers are affected by real wage rigidity. The measure is a fraction of workers who would have experienced a real wage cut without rigidities. As indicated by the wage change histograms, a large share (majority) of workers receives wage changes that are larger than expected inflation or even larger than contract wage rises during most years. In this sense, even large DRWR measures do not necessarily mean that wages are affected by DRWR for a large proportion of workers in general, as their notional wage changes exceed the expected inflation or even the contracted rise. That is, their desired wage change (by local bargaining and/or individual merit wage setting) is above the area affected by DRWR. However, a large DRWR does indicate that a large share of those workers who would otherwise be subject to real wage cuts, are restricted from experiencing such cuts and receive a real wage freeze instead. Whether this restriction is important for the numbers affected and the survival of jobs is likely to depend on the general business cycle conditions as well as the idiosyncratic demand and financial conditions of their employer firms.

In contrast to the stability of real wage rigidity, we observe an increasing tendency in the nominal wage rigidity during the financial crisis years (2007-2013). Before that period DNWR measures have been usually zero or close to it, except for the mini-recession years of early 2000's. This holds also for blue-collar workers in the earlier 1986-2000 period, but for monthly paid white collar workers and service sector workers Böckerman et. al. (2010) report high DNWR measure for the 1990's recession years. It therefore seems, that the nominal wage rigidity steps in during business cycle downswings, when there may be some slacking off in the real wage rigidity. Figure 21 presents the

combined or total effect of both real and nominal wage rigidities, and is consistent with the previous statement, as total rigidity is more stable than real wage rigidity alone. There is some tendency for the total rigidity to have increased during the last years of financial crisis, as the nominal wage rigidity has increased.

The IWFP protocol does not produce a measures for what fraction of all workers are affected by DRWR or DNWR, but it is possible to recover an estimate for those using the rigidity measures, observed share of nominal and real wage cuts, and the average values of the wage cuts[6]. The fraction of workers who experience a nominal wage freeze can be obtained as f=nB/(1-n), where n is the estimated DNWR, B is the observed share of nominal wage cuts. Similarly, the fraction of workers who receive a real wage freeze can be obtained as f=rB/(1-0.5r), where B is now observed share of workers experiencing a real wage cut. The multiplier 0.5 for r in the denominator arises, because in measuring r it is assumed that the expected inflation varies and half of inflation rates are above the mean of expected inflation. We present these measures in Table 2 and Figure 22; together with an estimate of how much higher is the observed average wage change due to the increases in wage changes caused by wage rigidities. This extra wage growth is called wage sweep-up. They are calculated by multiplying the above fractions affected by the absolute values of average nominal and real wage cuts. This assumes that those workers experiencing wage freezes would have experienced wage cuts with the same distribution as those who did experience a wage cut.

The fraction affected by nominal freezes is usually very small as indicated by the average for the years 1996-2007. However, it rises during (severe) recessions as indicated by the average of almost 20% during the financial crisis (2009-2013). The fraction affected by real rigidity is consistently higher (29% for 1996-2008) and also increases during the recession (48% for 2009-2013). These numbers confirm that the bite of rigidities rises during recessions. The wage sweep-up due to nominal rigidity is innocuous during normal times (0.1%), but rises considerably during the crisis years (on average 1.5% during 2009-2013). The real wage sweep-up on the other hand is more significant at 1.6% annually during 1996-2008, and rises to 2.4% during crisis years 2009-2013. The total wage sweep-up therefore more than doubles from 1.7% (1996-2008) to 3.9% (2009-2013).

[6] The actual observed share of wage cuts and the observed mean of wage cuts are used here. This produces an *overestimate* for the fraction affected and for the wage sweep-up, because the observed numbers are overestimated due to the measurement error. The corresponding numbers should be based on the true wage change distribution, but they are not immediately available from the protocol. Therefore, the levels of these calculations must be interpreted with caution that they are overestimates. However, the changes over time are indicative of the true changes if the measurement effect is constant over time.

Three things should be noted from these sweep-ups. First, they are overestimates as explained in footnote 1, so we do not discuss implications from their level. Second, and most importantly, the previous calculations assume that abolishing wage rigidities does not affect the wage setting in any other way, which is unlikely. That is we do not really know what is the counterfactual in case all rigidities were abolished or reduced by for example increasing local bargaining. It could be that the average wage growth for those not affected by rigidity would rise, so there would be a counteracting rise in the total wage growth. This could happen because there are always firms and worker groups not affected by rigidity, but their observed wage growth has probably been reduced by bargained contracts. Second, the present (centralized) wage setting institutions have contributed to overall wage moderation during recessions, including the present crisis (as shown for example by the declining three year wage growth above). If the rigidities were abolished by repealing such (centralized or other) co-ordination in wage setting, this institutional wage moderation mechanism is lost. Then the overall wage growth would be higher without such institutional moderation than the actual observed wage growth has been. Therefore, the levels of wage sweep-up calculations must be interpreted with utmost care, because they are overestimates and there may be countervailing effects when wage-setting institutions are changed in order to reduce wage rigidities. However, their changes over time should be informative if these measurement biases are constant over time. The total wage sweep-up effect more than doubles during the financial crisis years (2009-2013) compared to the average of the previous decade. The increases in both the total rigidity measure and the total wage sweep-up reflect more binding restrictions on the wage setting caused by real and nominal rigidities, during the crisis years. When desired wage changes have declined due to several reasons, including slow inflation and productivity growth as well as poor demand conditions, the restrictions on wage setting from downward rigidities bite more.

Comparing the present rigidity measures to the previous ones in Böckerman et.al (2010) for an earlier period, we note from Table 3, that for the overlapping years of 1995/1996-2000/2001 the nominal rigidity is lower in the present results, and the real rigidity is higher. This is likely to be due the differences in wage measures and sectors across the studies. In both cases we find that the nominal rigidity rises during recessions; early 90's recession in IWFP and the financial crisis in HWSS data. During early 90's recession, this was accompanied by a substantial decline in real rigidity, which is not observed during the present crisis. This may be due to the more severe and abrupt nature of the 90's recession, which led to contractual nominal wage freezes. This led to substantial zero spikes during the 90's recession and therefore to high nominal rigidity. Although inflation declined, it remained over 2% during the recession years. Therefore, the real rigidity measures dropped

considerably, because inflation exceeded the nominal wage change for most workers. That is, most workers experienced real wage cuts during the 90's recession. During the present crisis, nominal rigidity also rose, but there have not been such large zero spikes. The wage contracts have remained positive and close to inflation (mostly below it) during the financial crisis, which has retained the real rigidity measures high.

Figure 24 presents the estimates for average real and nominal wage rigidity for all countries in IWFP project. For real rigidity Finland is among the high rigidity countries together with Sweden and France, with average DRWR measures around 0.50. On the other hand, Finland is among low nominal rigidity countries together with Germany, Norway, Ireland and Belgium, with DNWR measures at 0.20 or lower. We are aware of only one more recent application of the IWFP protocol, so it is difficult to say whether this ranking of countries has changed over time[7]. Our new results for Finland are also difficult to compare to the earlier Finnish results due to above mentioned reasons to make any strong conclusions. But given the level difference during the common time period in the late 90's, and the development of HWSS based measures since then, it seems that there is some tendency for the nominal rigidity to rise and real rigidity to decrease during "normal times" (2002-2007 period). However, during the financial crisis both rigidities rose to high levels, so the relative standing of Finland as a high rigidity country overall has likely not been changed.

6. Other ways to adjust wage costs

Firms have other margins to adjust wage costs in addition to cuts in contractual (hourly) wages in case the firm faces an adverse shock and it needs to adjust its wage bill. The regular working time or overtime hours for existing workers may be reduced or the firm may lay off (temporarily or permanently) its workers. There is also natural or strategic turnover of workers from and to the firm. If the wage level or working hours of entrants differs from those of leavers, the firms wage costs change.[8] In order to examine the importance of these margins we perform a decomposition of the

[7] Deelen and Verbeek (2015) present results for the Netherlands over the years 2006-2012, which places Netherlands among the high real rigidity and low nominal rigidity countries.

[8] We are able to include only direct wage costs in this examination. Employer social security payments, pecuniary or non-pecuniary fringe benefits and annually paid performance bonuses are not included, although they allow for additional margins for labour cost adjustment.

annual change in the firm's wage bill following the decompositions presented in Fuss (2009) and Deelen (2016), as follows (firm subscript omitted for clarity)

$$\dot{WB}_t = [(N_t - E_{t-1}).\overline{H}_t^S.\overline{w}_t^{hS} + S_t\overline{H}_t^S(\overline{w}_t^{hS} - \overline{w}_{t-1}^{hS}) + S_t\left(\overline{H}_t^S - \overline{H}_{t-1}^S\right).\overline{w}_{t-1}^{hS} +$$

$$(\overline{w}_t^{hN} - \overline{w}_t^{hS})N_t.\overline{H}_t^N - (\overline{w}_{t-1}^{hE} - \overline{w}_t^{hS})E_{t-1}.\overline{H}_{t-1}^E +$$

$$\left(\overline{H}_t^N - \overline{H}_t^S\right)N_t.\overline{w}_t^{hS} - \left(\overline{H}_{t-1}^E - \overline{H}_t^S\right)E_{t-1}.\overline{w}_t^{hS}\ ]\ /\ \overline{WB_{it,t-1}}$$

where S_t, N_t and E_t are the numbers of continuing, entering, and exiting workers in the firm; $\overline{H}_t^S$ and $\overline{w}_t^{hS}$ denote the average regular working time and hourly wages for continuing workers; superscripts N and E denote corresponding averages for entering and exiting workers; and WB denotes the firms total wage bill. The left hand side is the annual percentage change in the firms wage bill as a proportion of the firms average wage bill over the two years. On the right hand side, the first term gives the effect of employment change, the second the effect of change in average hourly wages for continuing workers, and the third term gives the effect of changes in average regular working time of continuing workers. The term on the second line gives the entry-exit-wage effect due to the differences in the average wages of entrants and exiters, and the term of the third line gives a similar effect from average working time for entrants and exiters. The overtime effect is calculated as the difference between total wage bill (including overtime) and the wage bill for regular working time. All firm level averages are weighted by the individual worker's regular working hours. The aggregate decomposition is obtained as a weighted average of these firm level components, weighted by the sampling weight of firms.

Table 4. presents the results for this decomposition averaged over all (continuing) firms and years 1996-2013. Figure 25 depicts the decompositions for each year. The decomposition is averaged separately for firms in "good state" – sales increasing from the previous year – and firms in "bad state" – sales declining from previous year. Except for the employment change component, there are no major differences in the components between firms in good and bad state. The wage bill is increasing strongly in firms that face positive changes in their sales, because the firms are employing new workers. Conversely, the wage bill is declining by over 6% in firms facing declining sales, because the firms are employing less workers. On the other hand, the average wage bill growth due to wage growth of continuing workers in growing sales firms is 2 % per year, whereas it is only somewhat smaller at 1.5% in declining sales firms. The differences also in other margins between good and bad state firms are quite small, including the adjustment of overtime.

It therefore seems that the bulk of downward adjustment in wage costs falls on layoffs of workers in firms facing negative shocks. In this respect our results are very similar to those for the Netherlands in Deelen (2016). However, it must be stressed, that these results do not necessarily imply causality from sales reductions to employment declines due to rigid wages. It is possible that the causality is reversed, that is, a firm may be cutting its operations for some other reason than high wages. Then it is reductions in production and employment, which lead to reclining sales. To partially correct for this, we use changes in operating profits to stratify firms in to good and bad state. These results are presented in Table 5. Employment change is again the primary channel for downward adjustment of the wage bill in firms facing negative (profit) shocks, but the difference is notably smaller than in case of sales. Furthermore, reverse causality is a potential issue also in case of our profit measure, because it measures the change in firm's total profits, so one must be careful in making causal conclusions from these results.

As another partial check for reverse causality, we ran (firm) fixed effects regressions using the bad state indicator as a regressor for each component. We used both changes in sales and profits to construct the bad state indicator. Then we ran three different specifications for each component. First, using only the current bad state indicator as a regressor to mimic the results in previous Tables, as follows

$$y_{i,t} = \alpha + \beta . D_{badstate} + \gamma_i + \varepsilon_{i,t}.$$

Second, we used the lagged bad state indicator as a regressor to control for reverse causality, and third, we added year dummies as regressors to control for common year effects so that the bad state effects would reflect only differences between firms in otherwise similar (macroeconomic) conditions. In addition, firm fixed effects in all regressions control permanent differences between firms. The results are in Tables 6 and 7.

It is notable that the bad state coefficients are smaller and less significant when the lagged indicators are used, especially in the case of sales indicator. The same holds even more strongly when time dummies are added to the model. In case of the sales indicator, all coefficients are insignificant at 5 % level. However, in case of the profits indicator, the coefficients on employment change, stayer wage change and entry-exit hours effect remain significantly negative. The hourly wage cuts of continuing workers diminish the firms wage bill by about 0.14% in a firm experiencing negative profit changes compared to firms facing growing profits. The comparable effect for the decline in employment is over 5 times larger at approximately 0.76%. The shorter working hours of entering workers compared to exiting workers decreases the firms wage bill by an additional 0.21%. In total,

the wage bill change is 1.24% lower in bad state firms compared to good state firms, based on this model. It is clear that the bulk of the adjustment occurs via employment, but the numbers are far smaller than in the first model using current sales change. This indicates that that those estimates are likely to be contaminated by reverse causality to a substantial extent.

Overall, it seems that the primary margin to adjust wage costs in firms is the adjustment of employment, rather than other possible margins, such as wages, overtime or regular working hours, or turnover of employees. Especially wage cuts of existing workers are not used to any substantial amount in order to adjust to negative shocks, as probably expected given the wage rigidity estimates above. There may be some trade-off between wage and employment adjustment when firms face negative shocks, but its importance is difficult to estimate due to possible reverse causality effects.

As another simple attempt to examine the responsiveness of wages to employment shocks we examine correlations between firm-level employment changes and changes in firm-level producer real wages. It is clear that such correlations are purely descriptive and do not strictly identify any structural relations. To obtain these correlations we run regressions for firm's average wage changes on its current and lagged employment changes (three lags) controlling for year effects and differences between industries (at one digit level) and the full set of year-industry interactions. These are reported in Table 7 panel (a) for number of workers as the employment measure, and in panel (b) for total hours worked. In the first column, the coefficients (elasticities) are small and only the second lag is significant. This correlation does not reflect pro-cyclical business cycle effects common for all firms, because year-industry effects control for business cycles, which vary between industries. It is more likely due to firm-level (demand) shocks, which produce the positive overall correlation between wages and employment. To the extent that these results are driven by such demand shocks and there has not been major changes in firm-level wage pressures, the small coefficients imply that the responsiveness of wages to firm-level demand shocks is not very high, i.e. the "local" wage setting curve is very flat. Note again, that the year and industry effects essentially control for the aggregate wage setting effects common to all firms, such as centralized (industry level) contracts and their responsiveness to aggregate unemployment, so these results do not necessarily imply flat overall wage setting curves.

In order to examine if this relationship has changed during the financial crisis I stratify by periods (1995-2008 and 2009-2013) in column 3. There is not much difference between them, but if anything, the effects are larger during the crisis years. Second, to examine asymmetries between employment increases and declines, I stratify by employment growth or decline in column 5. Current and first lag is significant only for employment growth, but second and third lags are significant for firms

experiencing declines in employment. This seems consistent with the idea that wages increase faster when employment grows, but wage cuts are delayed when employment declines. The effect is furthermore asymmetric, as the size of wage cuts (0.008 using the sum of all lags) is almost half of the wage increases (0.014) when employment grows. Adding the lagged dependent on the right hand side has no material effect of the results. The negative autocorrelation of wage changes probably reflects both the measurement error and regression towards mean effects. All results using working hours as the employment measure in panel (b) are essentially similar.

7. Summary

Wage dispersion has increased quite substantially from mid 1990's until the present crisis. Wage differences as measured by the P90/P10 differential have widened by about 15 % from 1995 to late 2000's. However, during the financial crisis, dispersion has been more or less constant or growing only slowly depending on the measure used. Standard deviations for log wages and earnings increased during this period, but coefficients of variation, which take into account the increasing real wage level, have been almost flat. Overall, the dispersion measures increased during the 1995-2007 period, but have slowed down or stopped since then.

During late 1990's, the increase in between-firms variance dominated the within-firms increase, but during 2000's the overall increase in wage dispersion has occurred within-firms. This implies that during the last decade the increase in wage dispersion has been more related to characteristics of individuals (e.g. skill bias), or to the characteristics of their jobs (polarization), rather than characteristics of their employer firms (productivity, rents, monopsony) or assortative matching. The development in Finland seems to differ from that in many other countries where between-firms variation in wages have risen during recent decades. This is unlikely to relate only to labour market institutions, because the rising trend stopped in the early 2000's. If anything, there has been pressure from the employer side towards more decentralized bargaining since then, which should have increased the between firms variation in wages. The overall share of between firms variation in wages seems within the range of other countries, being smaller than in flexible USA and UK, but larger than in Sweden in the late 1990's. It seems that the common picture of Finland as a country with extremely small firm level variation in wages is not quite accurate.

For wage changes the between firms share of total variance is much smaller (about half) compared to wage levels. This probably reflects the relatively small local bargaining element in Finland due to

the wage settings institutions. The centralized wage setting institutions in Finland decrease variation in firm level wage changes and thereby keeps existing firm wage differences intact. The decline in between firms share in wage growth variation during the crisis is likely to reflect the increase in wage setting co-ordination during the crisis years.

Average working hours per month have dropped by about two hours from 1995 to 2013. At the same time, the dispersion of working time has increased, which implies that the working time for those working low hours has dropped more than for those working long hours. The average number of overtime hours has been quite steadily two hours with only a modest decline during the present crisis. Firms do not seem to use overtime hours to adjust their labour input.

The increase in real hourly wages has been around 3% annually, except during the 2010's when the increases have dropped below 2 %. Thus, there has been some real wage moderation during the crisis years. There is no systematic difference in the overall growth of consumption and producer real wages, although they may differ considerably in individual years. The real consumption wages have risen in all parts of the distribution above the 10^{th} percentile. However, for very low wages (the 1^{st} percentile) real earnings declined somewhat during the 1995-2001 period.

In order to minimize the effects of measurement error and other transitory wage changes, and better capture the cumulative effects over time we looked at average wage growth over 3-year periods. The three-year wage growth peaked at 10 % around 2005, then dropping to 2 % in 2013 for hourly wages of workers who continued in the same job. This implies even more considerable real wage moderation during the financial crisis than the annual figures above. It seems that the real wage cuts or slow wage growth cumulate to some extent to the same persons over time.

The concentration of wage changes to zero spikes are in general modest for both nominal and real wages, when averaged over all years. The largest spike is 4.3% for nominal wages of full-time monthly paid workers and the smallest is 0.3% for real hourly producer wages. However, for individual years during recessions, zero nominal spikes may be considerable, as in 1997 and 2009. During the previous severe depression in the 1990's zero spikes were even larger than during the present financial crisis.

The shares of negative nominal or real wage changes on the other hand are non-negligible. On average about a third of continuing prime aged workers experience an hourly wage change that is smaller than the contract wage raise or experience a real wage cut. About 16% experience a nominal wage cut. Corresponding shares for monthly earnings are a few percentage points smaller than for hourly wages. In addition, the means of these wage cuts are quite large. The largest mean cuts of almost -8% are for

the nominal wages. The average wage cuts for hourly real consumption and producer wages were between -5% and -6%, and for monthly earnings about -4% to -5%. The deviations from contract rises averaged from -3% to -5% depending on the wage measure.

The share of real wage cuts have increased during the financial crisis years (in 2011-2012 50-60% of workers experienced real wage cuts). The share of negative deviations from contract wage rises and their average size increased also during the financial crisis. These developments indicate increasing real wage moderation during the years of financial crisis. There also seems to be an element of individual or local wage setting, which produces smaller wage growth than the contract wage raises for some workers. On the other hand, the rising downward nominal wage rigidity seems to limit the size of these wage cuts. If nominal wage freeze limits the nominal cuts, then the size of inflation limits the size of real wage cuts. Therefore, low inflation during the crisis years is one factor limiting the downward adjustment of real wages.

Applying the methodology developed in the International Wage Flexibility Project (IWFP) to obtain parametric estimates of downward nominal and real wage rigidity, we find that downward real wage rigidity varies between 0.6 and 1 annually, averaging about 0.8 over the years 1995-2013. That is 80 % of workers potentially subject to DRWR, have been affected by it. For some individual years, like the recession years 1992-1993 and later in 2003 and 2007, the real rigidity has dropped to 0.15-0.35, but otherwise DRWR has been quite stable since mid 1980's around an average of about 0.8.

In contrast to the stability of real wage rigidity, we observe an increasing tendency in the nominal wage rigidity during the financial crisis. It seems, that the nominal wage rigidity steps in during business cycle downswings, when there may be some slacking off in the real wage rigidity. There is some tendency for the total rigidity to have increased during the last years of financial crisis, as the nominal wage rigidity has increased. This is likely to reflect that the restrictions on the wage setting caused by real and nominal rigidities have become more binding during the crisis years, when desired wage changes have declined due to several reasons, including slow inflation and productivity growth as well as poor demand conditions and increasing unemployment. Tentative calculations for the wage effect of these rigidities show that the wage sweep-up more than doubles during the present crisis. However, these wage sweep-up calculations must be taken as rudimentary. As explained in the main text, they are overestimates, and there are likely to be countervailing effects if wage-setting institutions were to be changed in order to reduce wage rigidities.

Firms have other margins to adjust wage costs in addition to cuts in contractual (hourly) wages in case the firm faces an adverse shock and it needs to adjust its wage bill. Using decompositions we

find that overall the primary margin to adjust wage costs in firms is the adjustment of employment, rather than other possible margins, such as hourly wages, overtime or regular working hours, or turnover of employees. Especially wage cuts of existing workers are not used to any substantial amount in order to adjust to negative shocks, as probably expected given the wage rigidity estimates above. There may be some trade-off between wage and employment adjustment when firms face negative shocks, but its importance is difficult to estimate due to possible reverse causality effects.

We also examined the responsiveness of wages to employment at the firm level. To the extent that the small responsiveness of firm-level wages to firm-level employment changes are driven by firm-level demand shocks and there has not been major changes in firm-level wage pressures, the "local" wage setting curve is very flat. Note however that the year and industry effects essentially control for the aggregate wage setting effects common to all firms, so these results do not necessarily imply flat overall wage setting curves. Furthermore, wages increase faster when employment grows, but wage cuts are delayed when employment declines. The effect is asymmetric, as the size of wage cuts is almost half of the wage increases when employment grows.

References

Barth Erling, Alex Bryson, James C. Davis, Richard B. Freeman (2016). It's Where You Work: Increases in Earnings Dispersion across Establishments and Individuals in the U.S. Journal of Labor Economics, 34 (2), s67-s97. Also as IZA DP 8437.

Böckerman Petri, Laaksonen Seppo and Vainiomäki Jari (2010), Micro and Macro Level Wage Rigidity: Lessons from Finland. Finnish Economic Papers 23, nro 1, Spring 2010, p. 27-42.

Card David, Jorg Heining, Patrick Kline (2013). Workplace Heterogeneity and the Rise of West German Wage Inequality. Quarterly Journal of Economics, vol 128, Issue 3, August 2013, pp. 967-1015.

Council of Economic Advisers (2016). Labor Market Monopsony: Trends, Consequences, and Policy Responses. Issue Brief, October 2016.
https://www.whitehouse.gov/sites/default/files/page/files/20161025_monopsony_labor_mrkt_cea.pdf

Davis, Steve J. and John Haltiwanger (1991). Wage Dispersion Between and Within U.S. Manufacturing Plants, 1963-1986. Brookings papers on Economic Activity, Microeconomics 1991, pp.115-200, September 1991.

Deelen Anja and Wouter Verbeek (2015) Measuring Downward Nominal and Real Wage Rigidity - Why Methods Matter. CPB Discussion Paper 315, Netherlands Bureau for Economic Policy Analysis.

Deelen Anja (2016). Flexible Wages Or Flexible Workers? A Decomposition of Wage Bill Adjustment by Dutch Firms, 2006-2013. CPB Netherlands Bureau for Economic Policy Analysis. Mimeo. December 29, 2016.

Dickens, W.T., L. Goette, E.L. Groshen, S. Holden, J. Messina, M.E. Schweitzer, J. Turunen, and M.E. Ward (2006). The Interaction of Labor Markets and Inflation: Analysis of Micro Data from the International Wage Flexibility Project. Brookings, Mimeo, Fall 2006.
http://www.frbsf.org/economics/conferences/0603/ilmi.pdf

Faggio, G., K. Salvanes and J. Van Reenen (2007). The evolution of Inequality in Productivity and Wages: Panel data evidence. Norwegian School of Economics and Business Administration, Discussion paper SAM 19, 2007.

Fuss, C. (2009). What is the most flexible component of wage bill adjustment? Evidence from Belgium. Labour Economics, 16(3):320-329.

Marjanen R. (2002). Palkkaratkaisujen sisältö ja toteutuminen tulopolitiikan aikakaudella. (In Finnish). The Research Institute of the Finnish Economy, Series B 188.

Song Jae, David Price, Fatih Guvenen, Nick Bloom, Till von Wachter (2015). Firming Up Inequality, NBER Working Paper 21199, May 2015. (Forthcoming in Firms and the Distribution of Income: The Roles of Productivity and Luck, Ed by Edward Lazear and Kathryn Shaw, NBER book)

Table 1. Shares of negative and zero wage changes and average of negative wage changes, 1996-2013

Wage measure and group	Share negative	Share zero	Average negative
Nominal, hourly, all	16.0 %	2.8 %	-8.1 %
Nominal, hourly, 25-55	15.8 %	2.8 %	-7.8 %
Nominal, monthly, full time, all	10.3 %	4.3 %	-7.8 %
Nominal, monthly, full time, 25-55	10.3 %	4.3 %	-7.6 %
Real, hourly, all	30.3 %	1.0 %	-5.6 %
Real, hourly, 25-55	29.7 %	1.0 %	-5.4 %
Real, monthly, full time, all	26.8 %	1.4 %	-4.2 %
Real, monthly, full time, 25-55	26.1 %	1.4 %	-4.2 %
Contract, hourly, all	35.4 %	1.5 %	-4.7 %
Contract, hourly, 25-55	34.9 %	1.6 %	-4.6 %
Contract, monthly, full time, all	32.4 %	2.2 %	-3.3 %
Contract, monthly, full time, 25-55	31.9 %	2.3 %	-3.3 %
Producer real, hourly, 25-55	35.9 %	0.3 %	-6.1 %
Producer real, monthly, full time, 25-55	33.9 %	0.3 %	-4.8 %

Note: All numbers are for annual changes for continuers, i.e. persons who work for the same employer in the same occupation in two consecutive years.

Table 2. Wage effects of downward wage rigidities

Period	Fraction nominal	Fraction real	Sweep-up nominal	Sweep-up real	Sweep-up total
1996-2008	1.3 %	29.2 %	0.10 %	1.62 %	1.72 %
2009-2013	18.7 %	48.1 %	1.54 %	2.37 %	3.91 %

Note: Fractions are shares of workers subject to rigidity of all workers. Sweep-ups are the average annual amounts of extra wage growth due to rigidity.

Table 3. Comparison of rigidity measures with previous ones for Finland

Period	IWFP nominal	HWSS nominal	IWFP real	HWSS real
1986-1990(1991)	0.15		0.51	
1991(1992)-1993(1994)	0.70		0.09	
1994(1995)-2000(2001)	0.21	0.03	0.59	0.79
2002-2007		0.09		0.54
2008-2013		0.41		0.77

Note: The IWFP numbers are unweighted averages of measures estimated separately for three sectors: manufacturing blue collar workers, manufacturing white collar workers and service sector workers. The blue collar results are for hourly wages, like the HWSS, but the other two sectors are for monthly earnings. The depression period is 1992-1994 for the service sector and 1991-1993 for the other two sectors. The start and end years of other periods are affected consistently with this.

Table 4. Decomposition of the change in wage bill by Sales status, average over all years 1996-2013

Component	Dsales>0	Dsales<0	Difference
Stayer wage change	2.0 %	1.5 %	-0.5 %
Stayer hours change	0.4 %	0.3 %	-0.2 %
Employment change	4.9 %	-6.3 %	-11.2 %
Entry-exit wages	-0.6 %	-0.4 %	0.3 %
Entry-exit hours	1.5 %	1.6 %	0.1 %
Total change (regular time)	8.2 %	-3.3 %	-11.5 %
Overtime pay	0.2 %	-0.1 %	-0.3 %
Number of firm-year obs	66226	36858	

Note: weighted by hours at individual level and by sampling weights at firm level.

Table 5. Decomposition of the change in wage bill by Profit status, average over all years 1996-2013

Component	Dprofit>0	Dprofits<0	Difference
Stayer wage change	1.9 %	1.7 %	-0.2 %
Stayer hours change	0.4 %	0.3 %	0.0 %
Employment change	2.3 %	-0.9 %	-3.2 %
Entry-exit wages	-0.8 %	-0.2 %	0.6 %
Entry-exit hours	1.6 %	1.5 %	0.0 %
Total change (regular time)	5.3 %	2.4 %	-2.9 %
Overtime pay	0.1 %	0.0 %	-0.2 %
Number of firm-year obs	54182	48902	

Note: weighted by hours at individual level and by sampling weights at firm level.

Table 6a. Regressions for the wage bill decomposition by Sales status

Current Sales change

	(1) empl_change	(2) stayer_wage	(3) stayer_hours	(4) entry_exit_wage	(5) entry_exit_hours	(6) sum_effects	(7) overtime_effect
badstate	-0.0928***	-0.00315***	-0.00116***	0.00718***	0.00138	-0.0885***	-0.00232***
	(-29.26)	(-7.73)	(-4.30)	(5.63)	(1.23)	(-27.77)	(-9.18)
N	103091	103091	103091	103091	103091	103091	103091
R^2	0.011	0.001	0.000	0.000	0.000	0.010	0.001

Lagged Sales change

	(1) empl_change	(2) stayer_wage	(3) stayer_hours	(4) entry_exit_wage	(5) entry_exit_hours	(6) sum_effects	(7) overtime_effect
L.badstate	-0.00655	-0.00135**	0.000166	0.000683	0.00147	-0.00557	0.00188***
	(-1.86)	(-3.09)	(0.62)	(0.50)	(1.22)	(-1.61)	(6.59)
N	78850	78850	78850	78850	78850	78850	78850
R^2	0.000	0.000	0.000	0.000	0.000	0.000	0.001

Lagged Sales change and time effects

	(1) empl_change	(2) stayer_wage	(3) stayer_hours	(4) entry_exit_wage	(5) entry_exit_hours	(6) sum_effects	(7) overtime_effect
L.badstate	-0.00497	-0.000828	0.000241	0.00114	0.00220	-0.00222	0.00168***
	(-1.39)	(-1.90)	(0.88)	(0.83)	(1.78)	(-0.63)	(5.79)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	78850	78850	78850	78850	78850	78850	78850
R^2	0.006	0.030	0.001	0.002	0.001	0.005	0.003

Robust t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. All regressions include firm fixed effects. Weighted by hours at individual level and by sampling weights at firm level.

Table 6b. Regressions for the wage bill decomposition by Profit status

Current Profits change

	(1) empl_change	(2) stayer_wage	(3) stayer_hours	(4) entry_exit_wage	(5) entry_exit_hours	(6) sum_effects	(7) overtime_effect
badstate2	-0.0221***	-0.00153***	0.0000693	0.00479***	0.00117	-0.0176***	-0.000859***
	(-7.73)	(-4.18)	(0.25)	(4.14)	(1.15)	(-5.96)	(-3.67)
N	103091	103091	103091	103091	103091	103091	103091
R^2	0.001	0.000	0.000	0.000	0.000	0.000	0.000

Lagged Profits change

	(1) empl_change	(2) stayer_wage	(3) stayer_hours	(4) entry_exit_wage	(5) entry_exit_hours	(6) sum_effects	(7) overtime_effect
L.badstate2	-0.00921**	-0.00148***	-0.0000749	-0.00143	-0.00242*	-0.0146***	0.000575*
	(-2.92)	(-3.86)	(-0.28)	(-1.22)	(-2.52)	(-4.76)	(2.40)
N	78850	78850	78850	78850	78850	78850	78850
R^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Lagged Profits change and time effects

	(1) empl_change	(2) stayer_wage	(3) stayer_hours	(4) entry_exit_wage	(5) entry_exit_hours	(6) sum_effects	(7) overtime_effect
L.badstate2	-0.00762*	-0.00139***	-0.0000105	-0.00133	-0.00209*	-0.0124***	0.000519*
	(-2.40)	(-3.65)	(-0.04)	(-1.13)	(-2.17)	(-4.03)	(2.15)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	78850	78850	78850	78850	78850	78850	78850
R^2	0.006	0.030	0.001	0.002	0.001	0.005	0.002

Robust t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. . All regressions include firm fixed effects. Weighted by hours at individual level and by sampling weights at firm level.

Table 7. Firm-level regressions between wage changes and employment changes

a. Change in employment as the independent variable

	(1)	(2)	(3)	(4)	(5)	(6)
dlnempl	0.00163	0.00228*				
	(1.66)	(2.32)				
dlnempl(t-1)	0.00162	0.00216*				
	(1.67)	(2.26)				
dlnempl(t-2)	0.00277**	0.00276**				
	(3.06)	(3.09)				
dlnempl(t-3)	0.00132	0.00151*				
	(1.78)	(2.07)				
dependent(t-1)		-0.171***				
		(-16.39)				
dlnempl*			0.00146	0.00186		
D(1996-2008)			(1.13)	(1.43)		
dlnempl*			0.00187	0.00290*		
D(2009-2013)			(1.27)	(1.98)		
dlnempl(t-1)*			0.00110	0.00203		
D(1996-2008)			(0.87)	(1.61)		
dlnempl(t-1)*			0.00240	0.00236		
D(2009-2013)			(1.61)	(1.63)		
dlnempl(t-2)*			0.00268*	0.00281*		
D(1996-2008)			(2.17)	(2.30)		
dlnempl(t-2)*			0.00291*	0.00259*		
D(2009-2013)			(2.21)	(2.00)		
dlnempl(t-3)*			0.00189	0.00190		
D(1996-2008)			(1.91)	(1.94)		
dlnempl(t-3)*			0.000436	0.000932		
D(2009-2013)			(0.40)	(0.86)		
dependent(t-1)*				-0.138***		
D(1996-2008)				(-10.06)		
dependent(t-1)*				-0.231***		
D(2009-2013)				(-14.83)		

	(1)	(2)	(3)	(4)	(5)	(6)
dlnempl*					0.00626***	0.00657***
Ddlnempl>0					(3.63)	(3.79)
dlnempl*					-0.00205	-0.00187
Ddlnempl<0					(-1.49)	(-1.30)
dlnempl(t-1)*					0.00398**	0.00564***
Ddlnempl>0					(2.64)	(3.79)
dlnempl(t-1)*					0.00172	0.00116
Ddlnempl<0					(1.13)	(0.78)
dlnempl(t-2)*					0.00359**	0.00386**
Ddlnempl>0					(2.65)	(2.91)
dlnempl(t-2)*					0.00421**	0.00446**
Ddlnempl<0					(2.69)	(2.89)
dlnempl(t-3)*					-0.000146	-0.000243
Ddlnempl>0					(-0.15)	(-0.25)
dlnempl(t-3)*					0.00408**	0.00482***
Ddlnempl<0					(2.90)	(3.41)
dependent(t-1)*						-0.162***
Ddlnempl>0						(-13.92)
dependent(t-1)*						-0.186***
Ddlnempl<0						(-10.80)
N	62847	62665	62847	62665	62847	62665

Robust t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

All models include year effects, one-digit industry effects and their interactions.

b. Change in working hours as the independent variable

	(1)	(2)	(3)	(4)	(5)	(6)
dlnhours	0.0000716	0.000792				
	(0.07)	(0.79)				
dlnhours(t-1)	0.00215*	0.00245*				
	(2.19)	(2.56)				
dlnhours(t-2)	0.00296**	0.00311***				
	(3.26)	(3.48)				
dlnhours(t-3)	0.00171*	0.00192**				
	(2.30)	(2.62)				
dependent(t-1)		-0.171***				
		(-16.37)				
dlnhours*			0.000349	0.000783		
D(1996-2008)			(0.26)	(0.59)		
dlnhours*			-0.000452	0.000792		
D(2009-2013)			(-0.30)	(0.53)		
dlnhours(t-1)*			0.00143	0.00226		
D(1996-2008)			(1.11)	(1.78)		
dlnhours(t-1)*			0.00326*	0.00266		
D(2009-2013)			(2.17)	(1.84)		
dlnhours(t-2)*			0.00275*	0.00296*		
D(1996-2008)			(2.23)	(2.43)		
dlnhours(t-2)*			0.00329*	0.00326*		
D(2009-2013)			(2.50)	(2.51)		
dlnhours(t-3)*			0.00210*	0.00212*		
D(1996-2008)			(2.09)	(2.14)		
dlnhours(t-3)*			0.00111	0.00162		
D(2009-2013)			(1.01)	(1.51)		
dependent(t-1)*				-0.138***		
D(1996-2008)				(-10.05)		
dependent(t-1)*				-0.231***		
D(2009-2013)				(-14.82)		

	(1)	(2)	(3)	(4)	(5)	(6)
dlnhours*					0.00353*	0.00405*
Ddlnhours>0					(2.05)	(2.36)
dlnhours*					-0.00301*	-0.00290*
Ddlnhours<0					(-2.11)	(-1.98)
dlnhours(t-1)*					0.00528***	0.00660***
Ddlnhours>0					(3.54)	(4.51)
dlnhours(t-1)*					0.00101	0.000316
Ddlnhours<0					(0.66)	(0.21)
dlnhours(t-2)*					0.00409**	0.00460***
Ddlnhours>0					(3.04)	(3.48)
dlnhours(t-2)*					0.00419**	0.00446**
Ddlnhours<0					(2.69)	(2.91)
dlnhours(t-3)*					0.000482	0.000432
Ddlnhours>0					(0.49)	(0.45)
dlnhours(t-3)*					0.00431**	0.00506***
Ddlnhours<0					(3.06)	(3.59)
dependent(t-1)*						-0.160***
Ddlnhours>0						(-13.82)
dependent(t-1)*						-0.188***
Ddlnhours<0						(-10.94)
N	62847	62665	62847	62665	62847	62665

Robust t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

All models include year effects, one-digit industry effects and their interactions.

Figure 1. Standard deviations

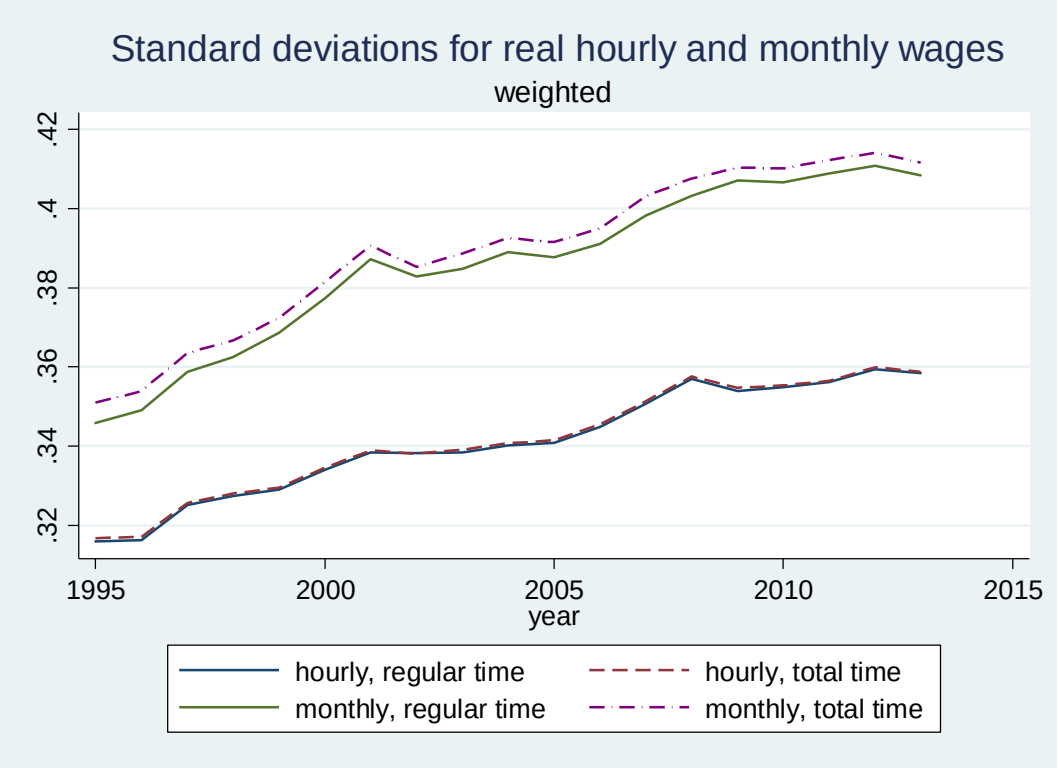


Figure 2. Percentile ratios

Figure 3. Percentiles

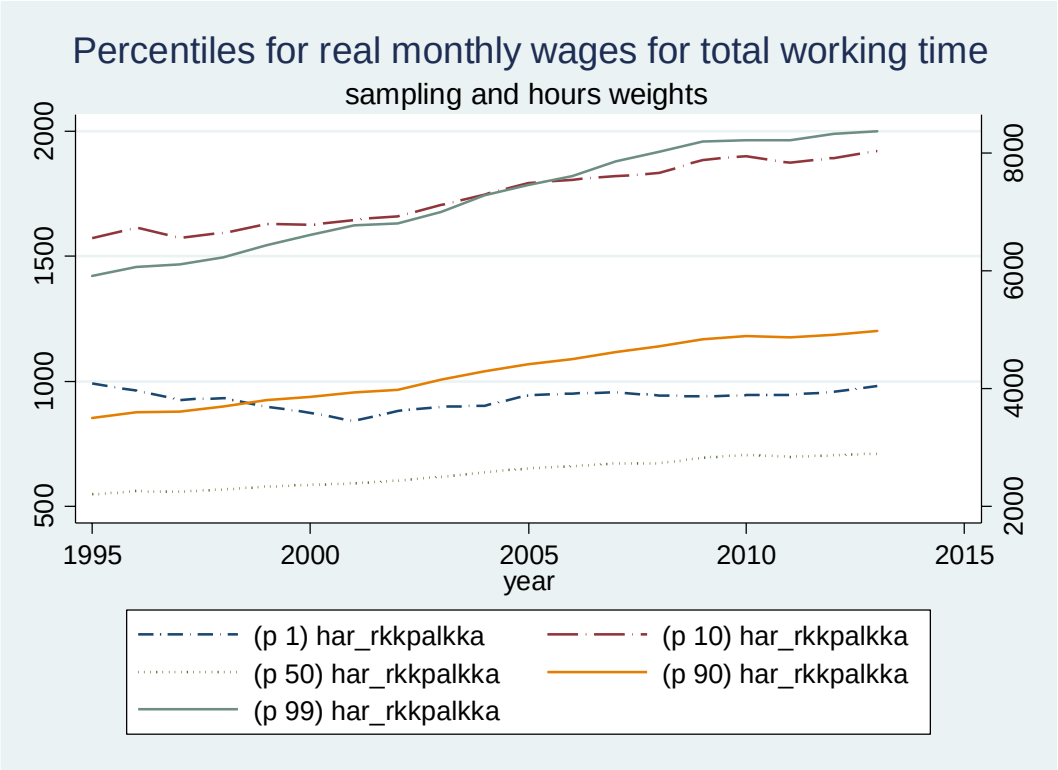


Figure 4. Top and bottom 1% ratio

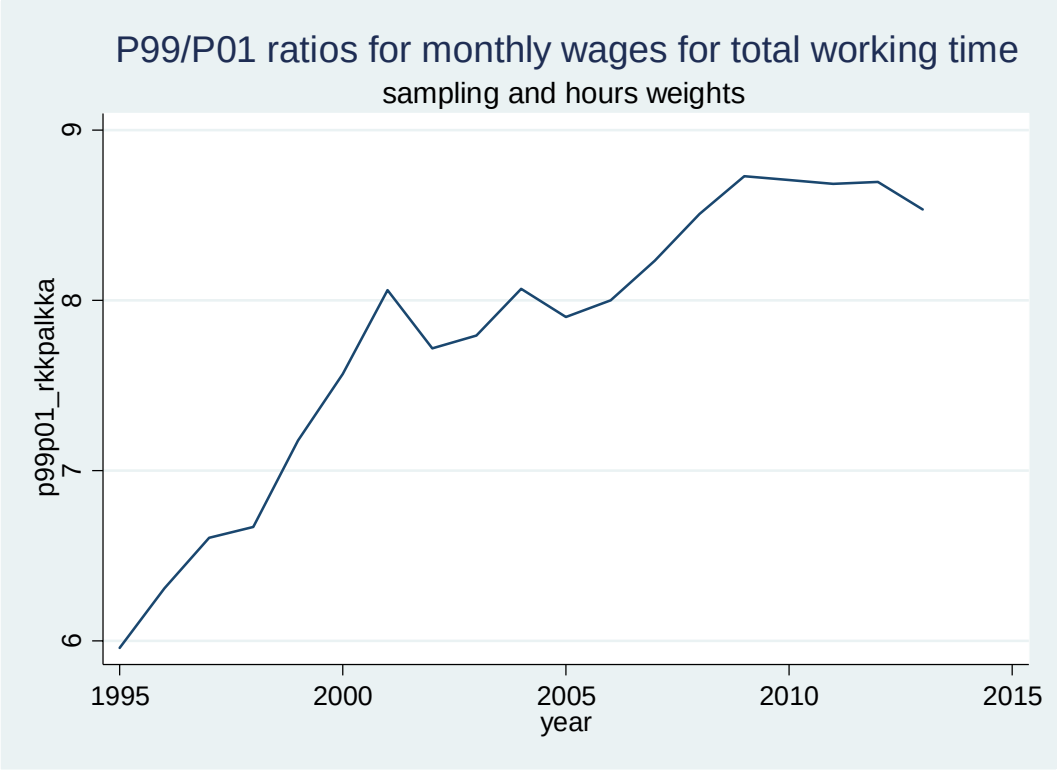


Figure 5. Mean and dispersion of working hours

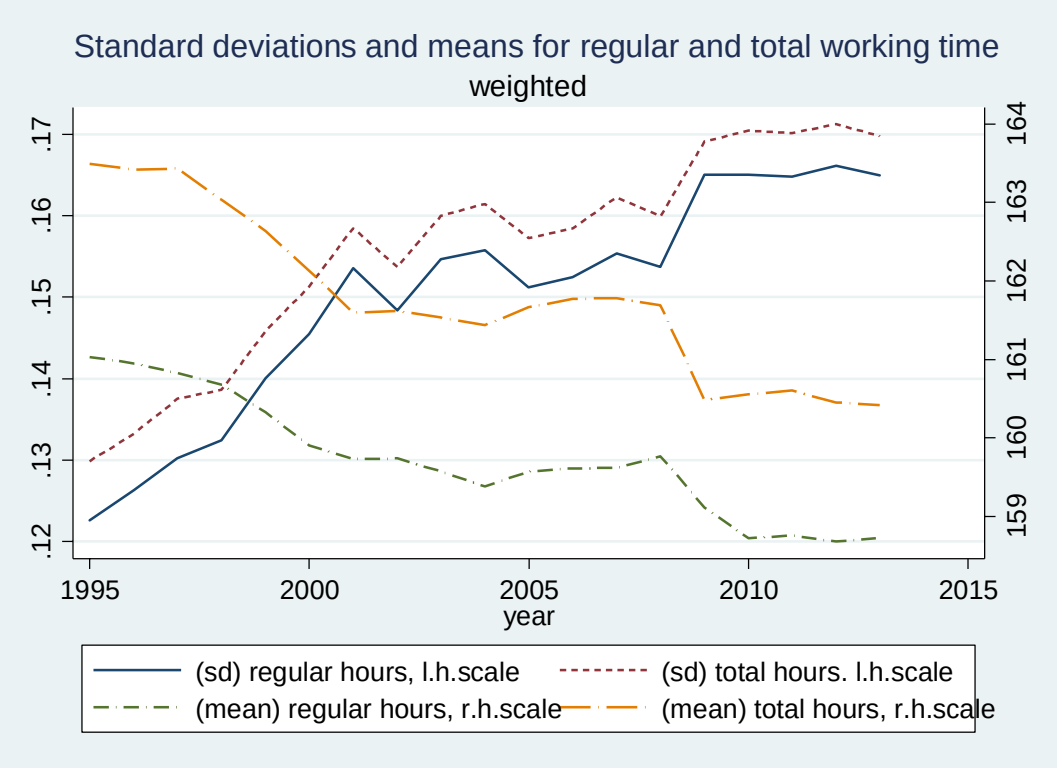


Figure 6. Within and Between firms decomposition for variance of monthly earnings

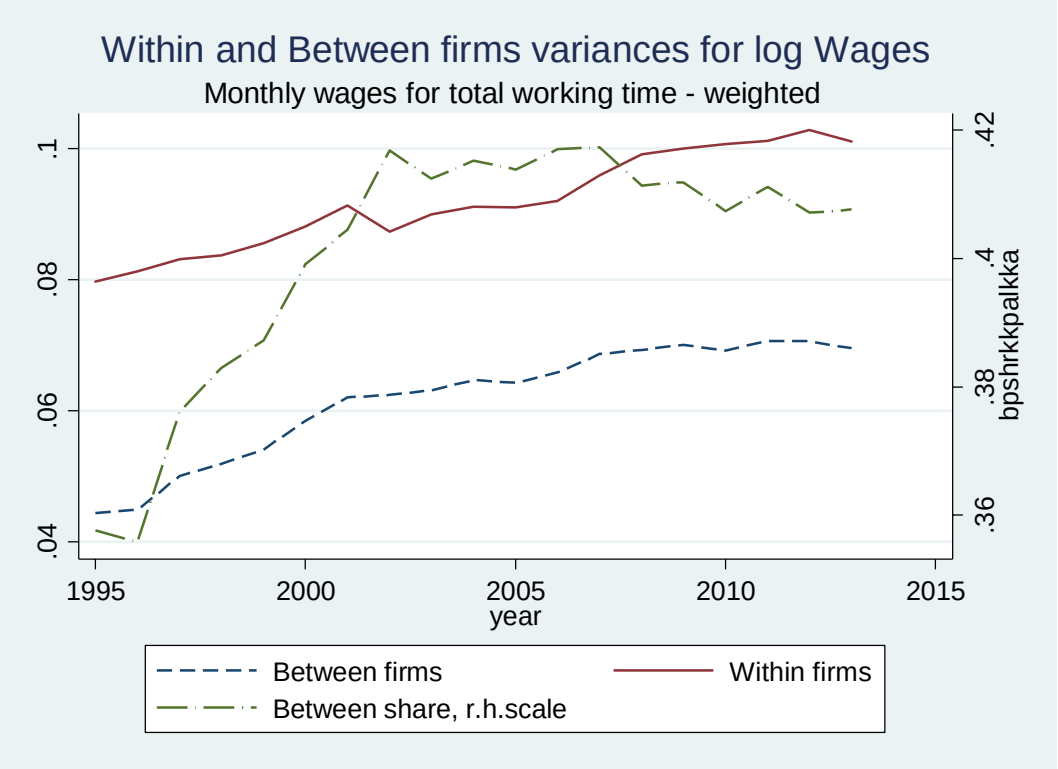


Figure 7a . Average real consumption wage increases and inflation

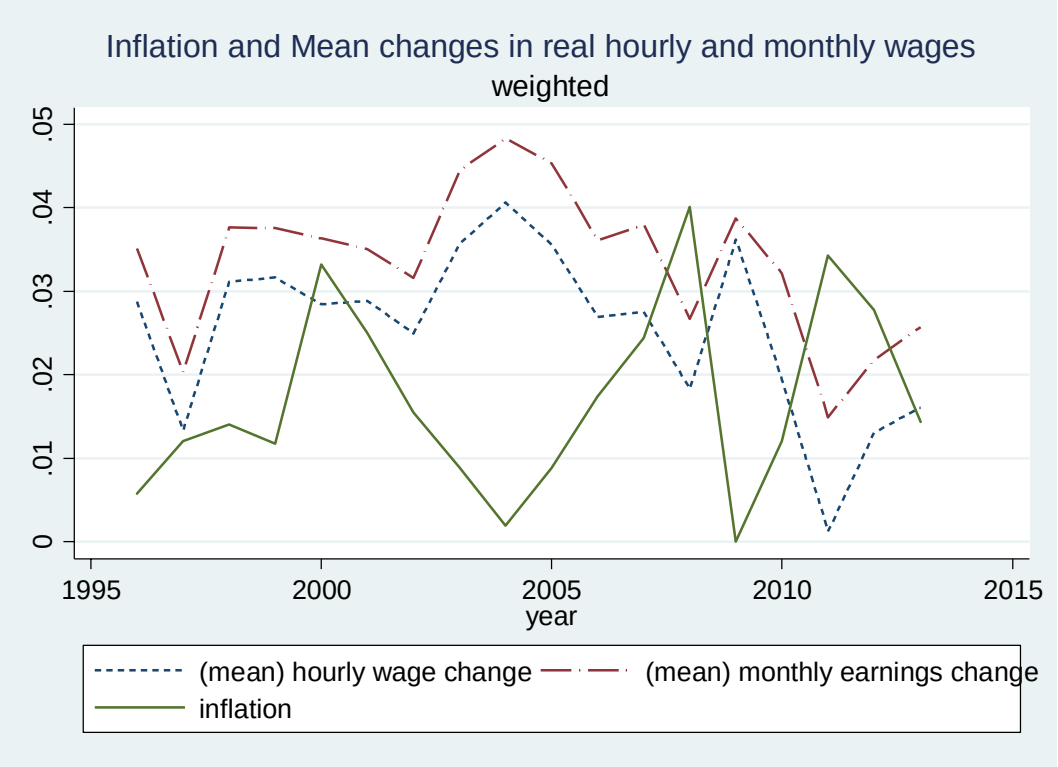


Figure 7b. Average real consumption and producer real wage growth

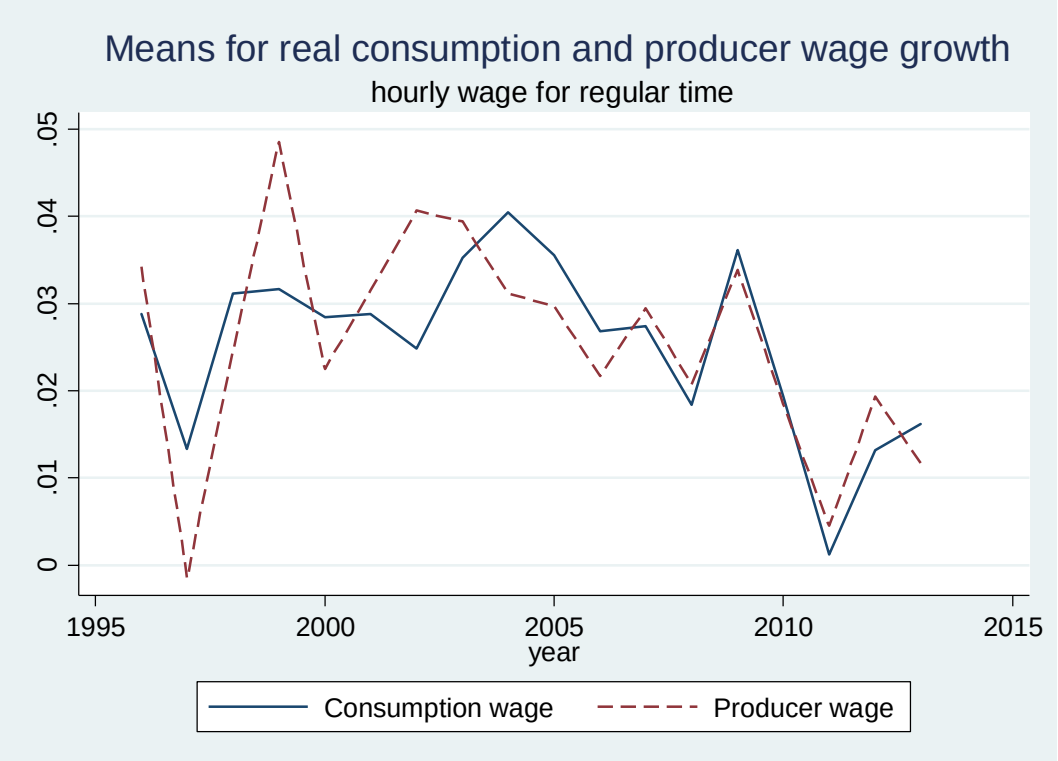


Figure 8. Standard deviation of wage increases

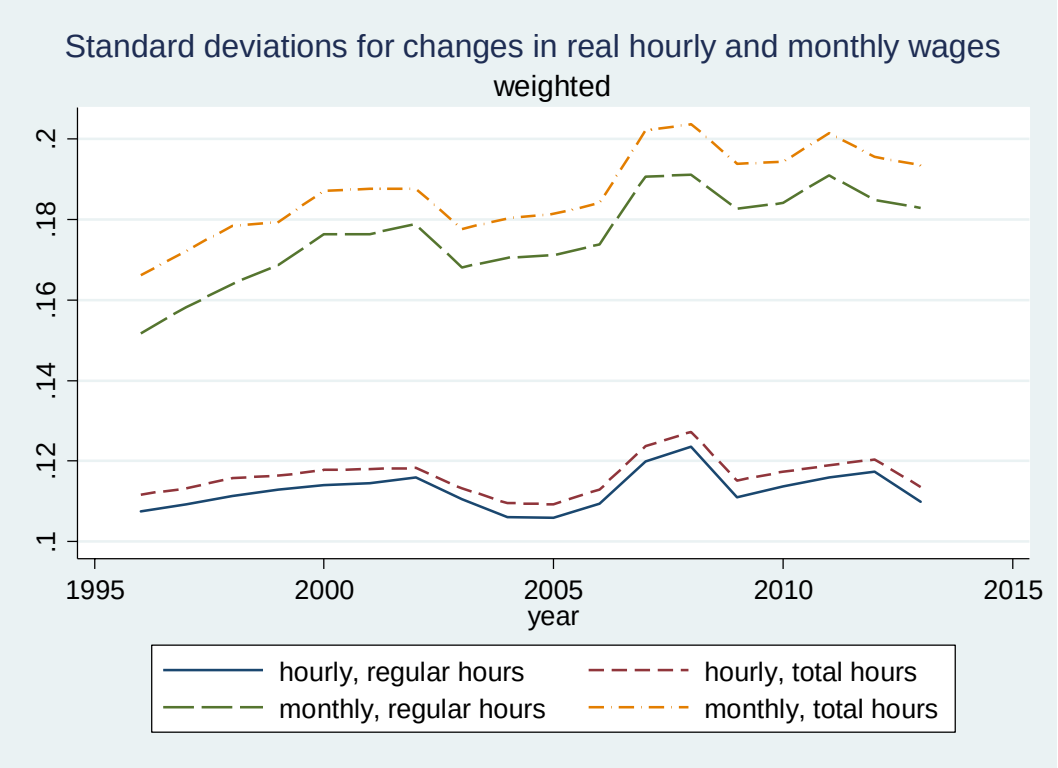


Figure 9 Within and Between firms variances for wage changes

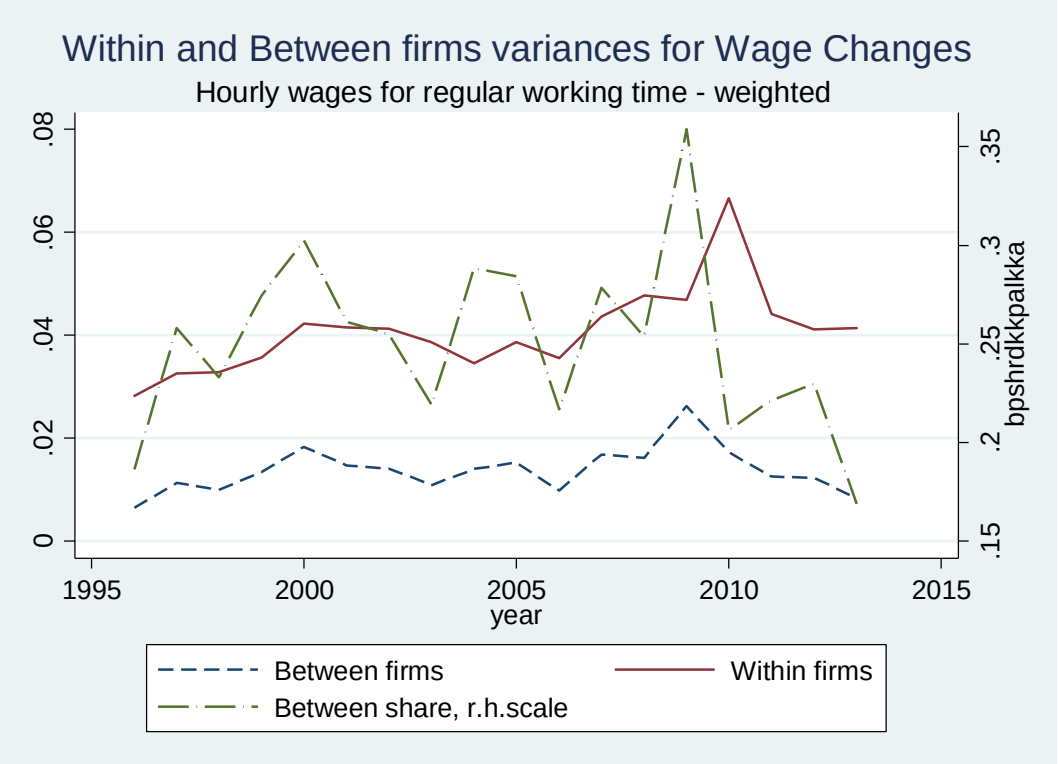
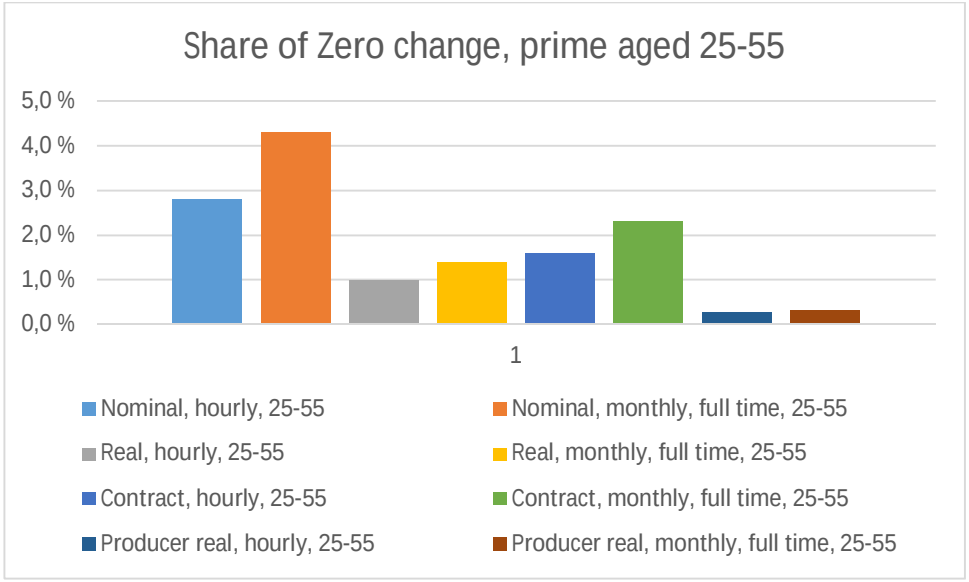
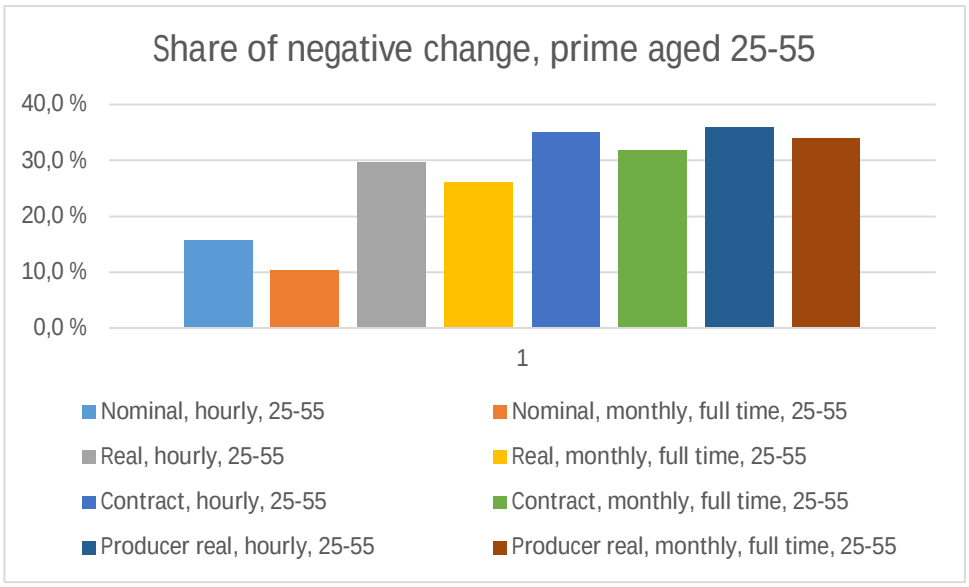


Figure 10. Share of zero and negative changes and their size





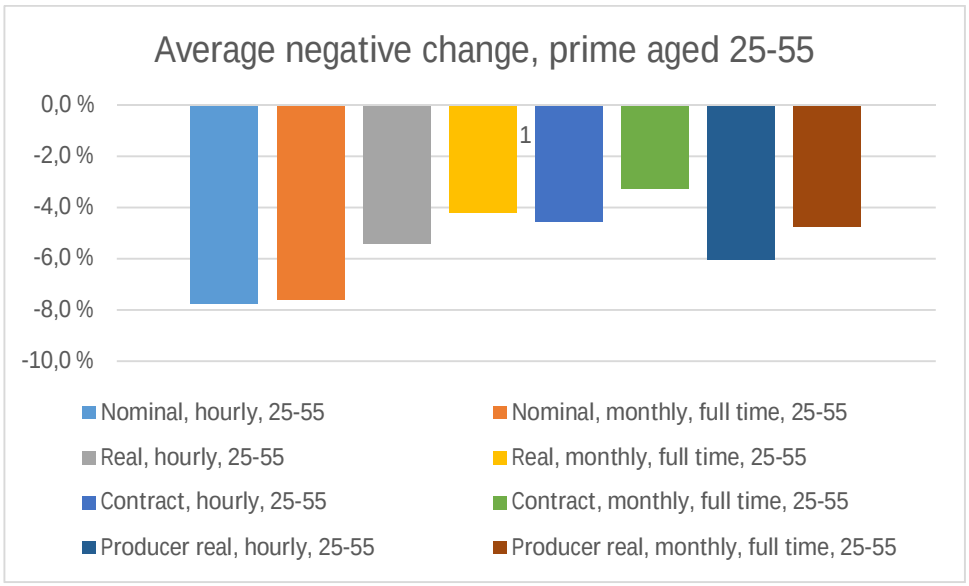


Figure 11 Development over the years of Zero nominal spike and nominal cuts

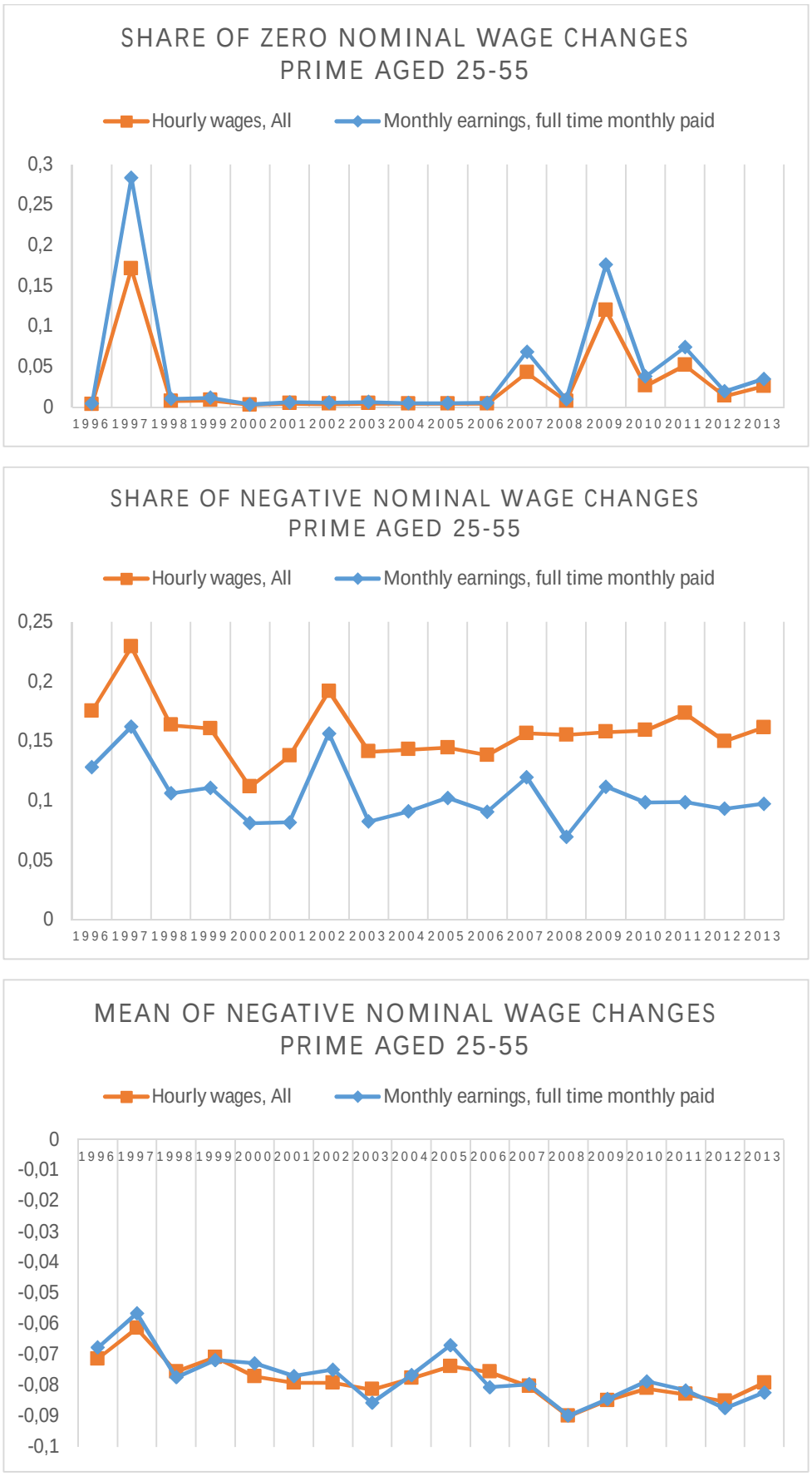
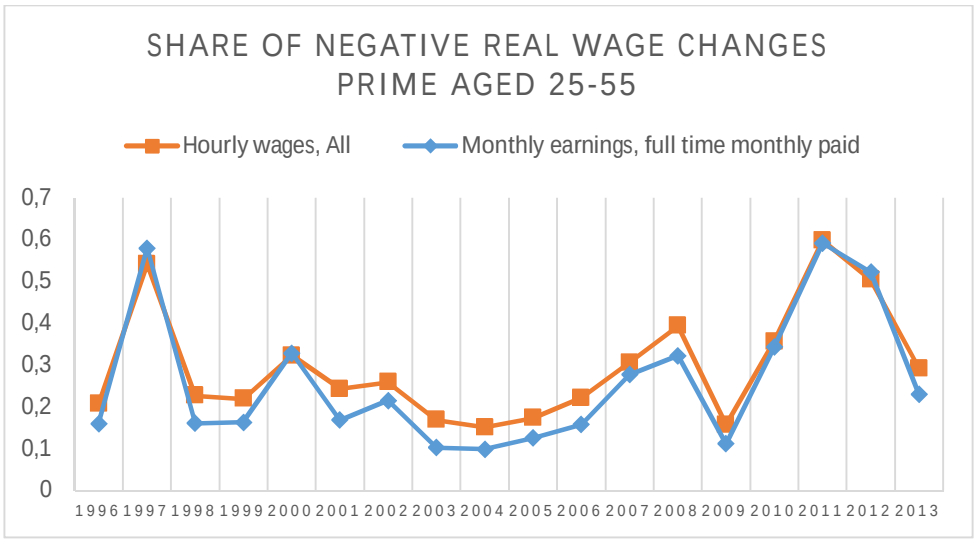


Figure 12 Development over the years of the share and size of real wage cuts



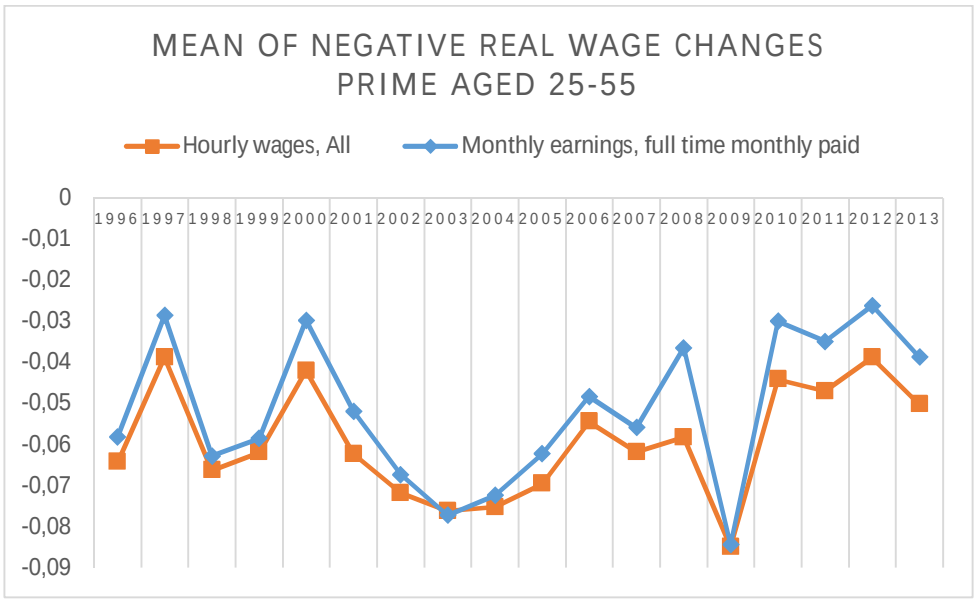
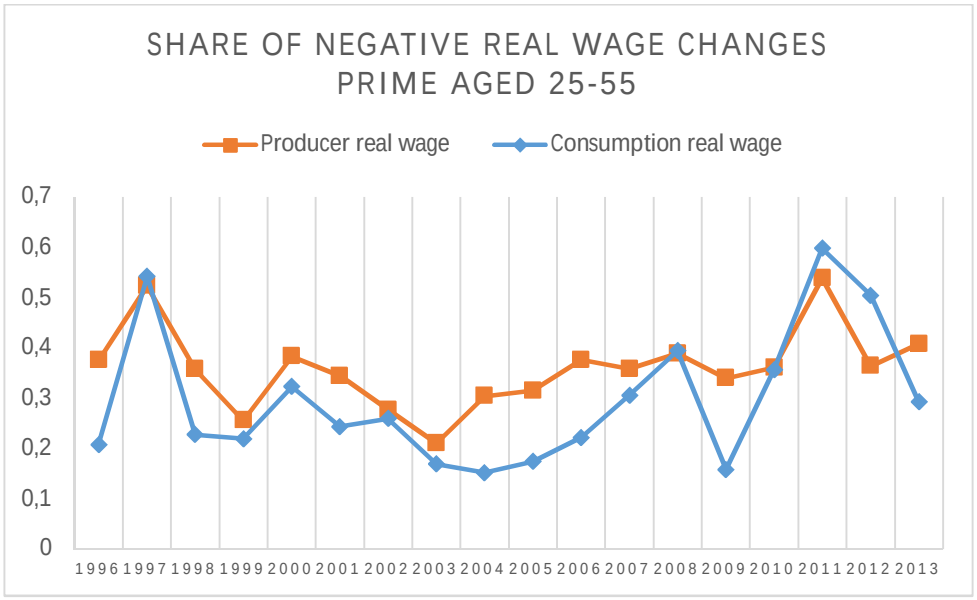


Figure 13 Comparison of consumption and producer real wage cuts



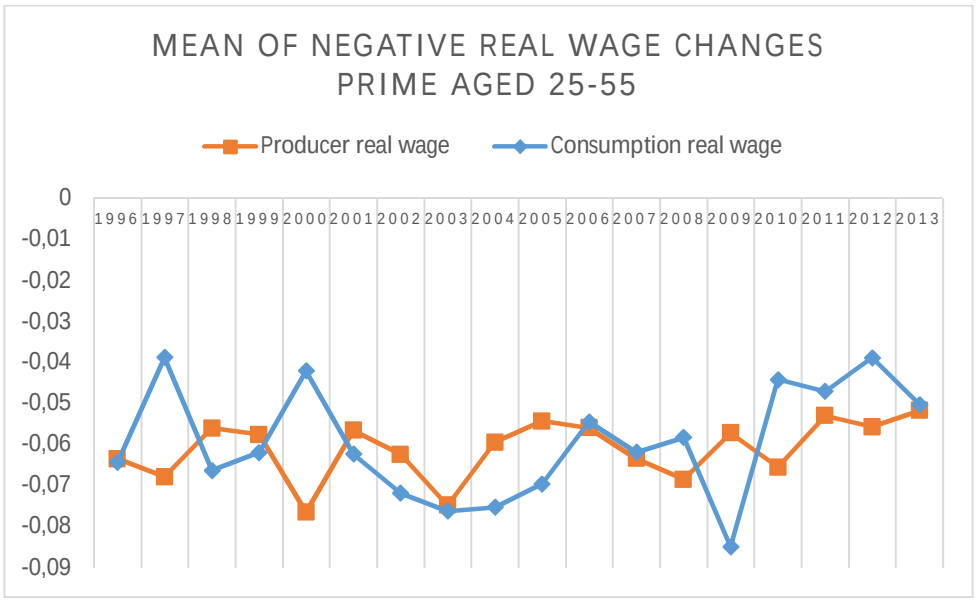


Figure 14 Development of the share of negative deviations from the contract rise

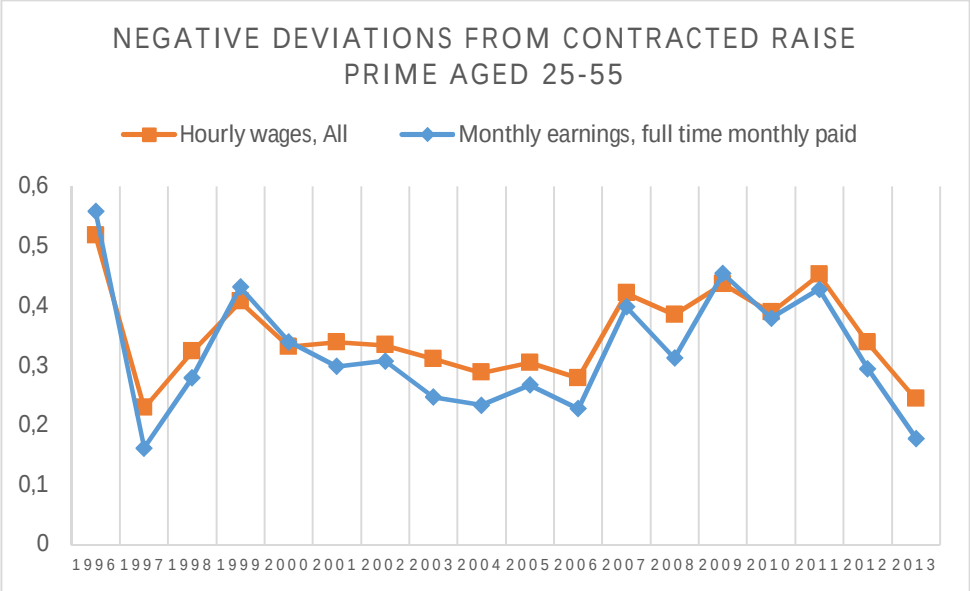


Figure 15 Development of the mean deviation from contract wage raise

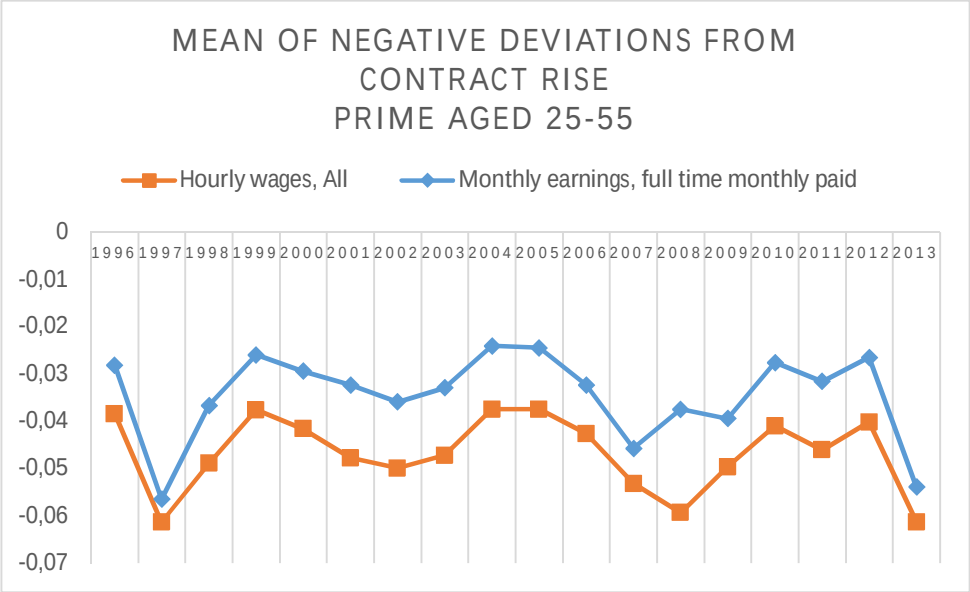
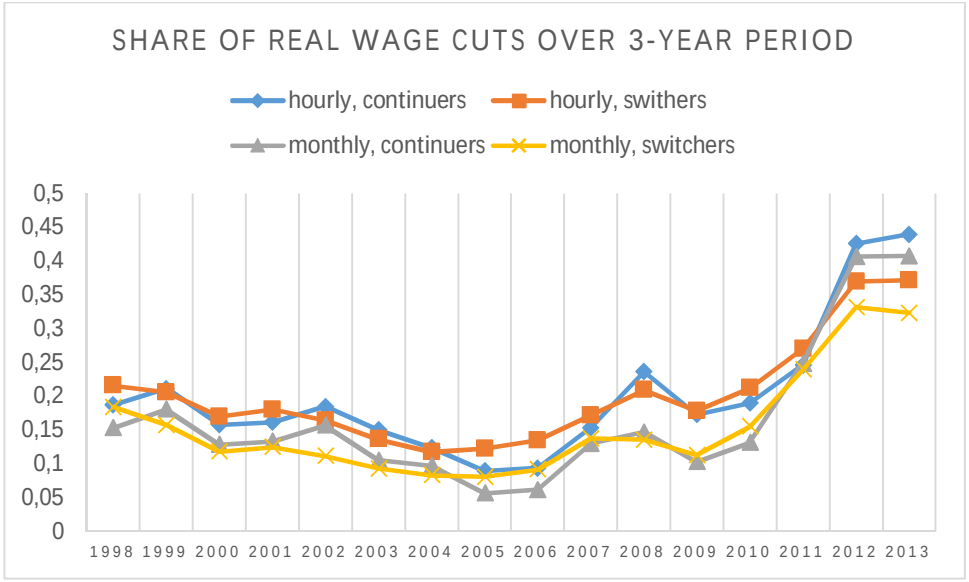
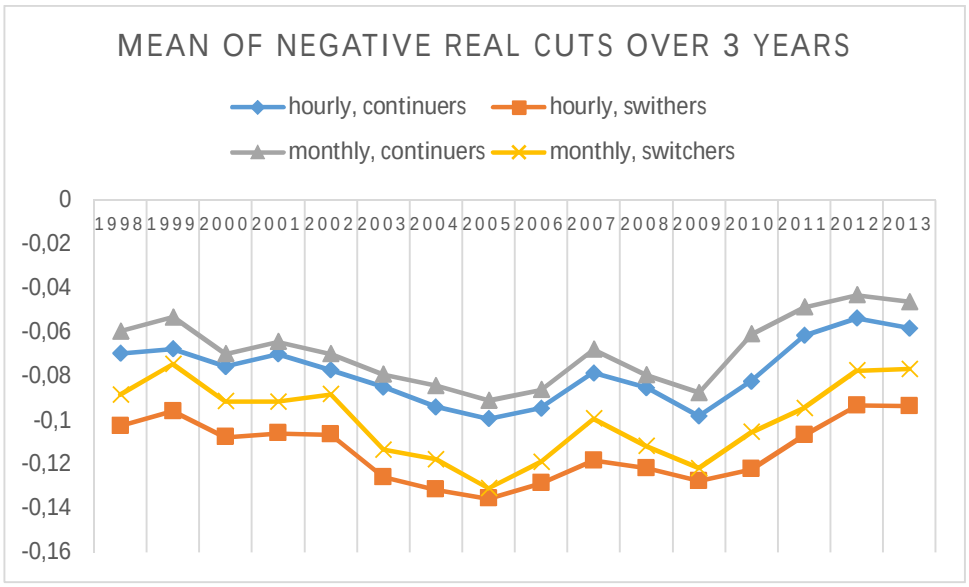


Figure 16 Real wage changes over three year periods





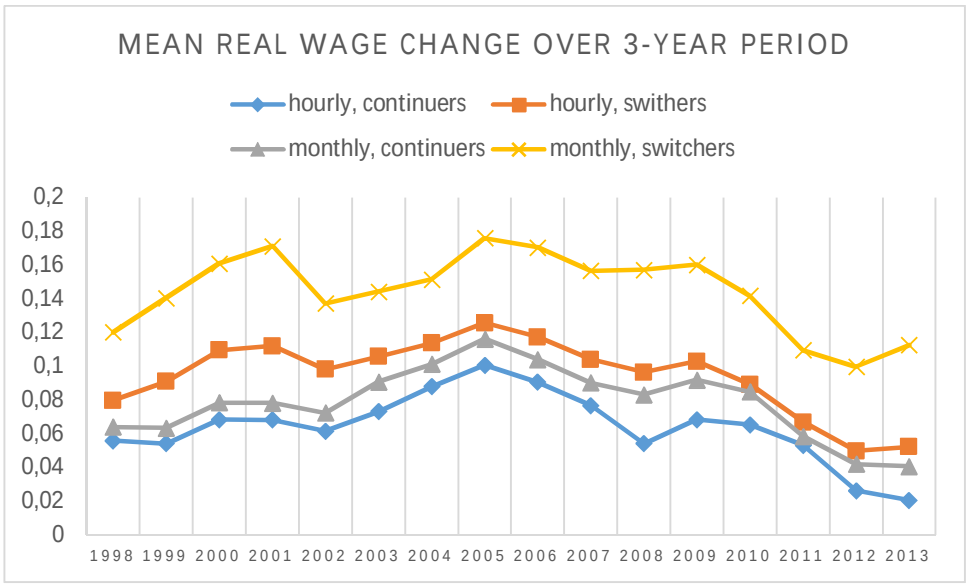
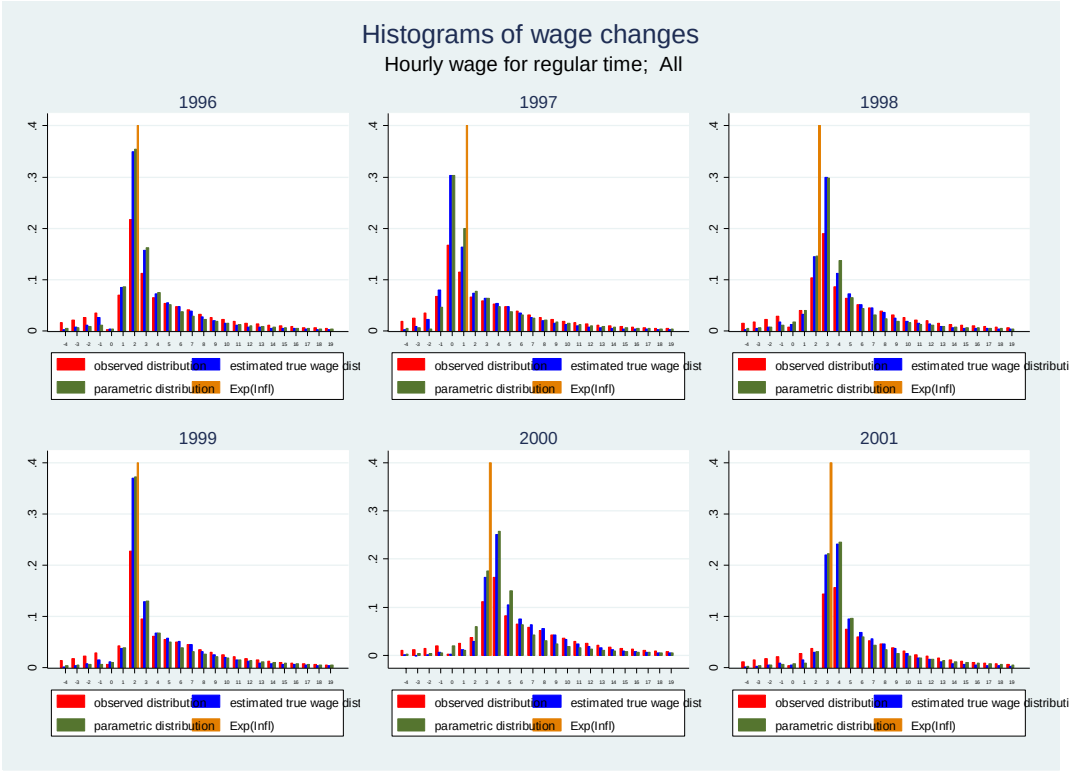
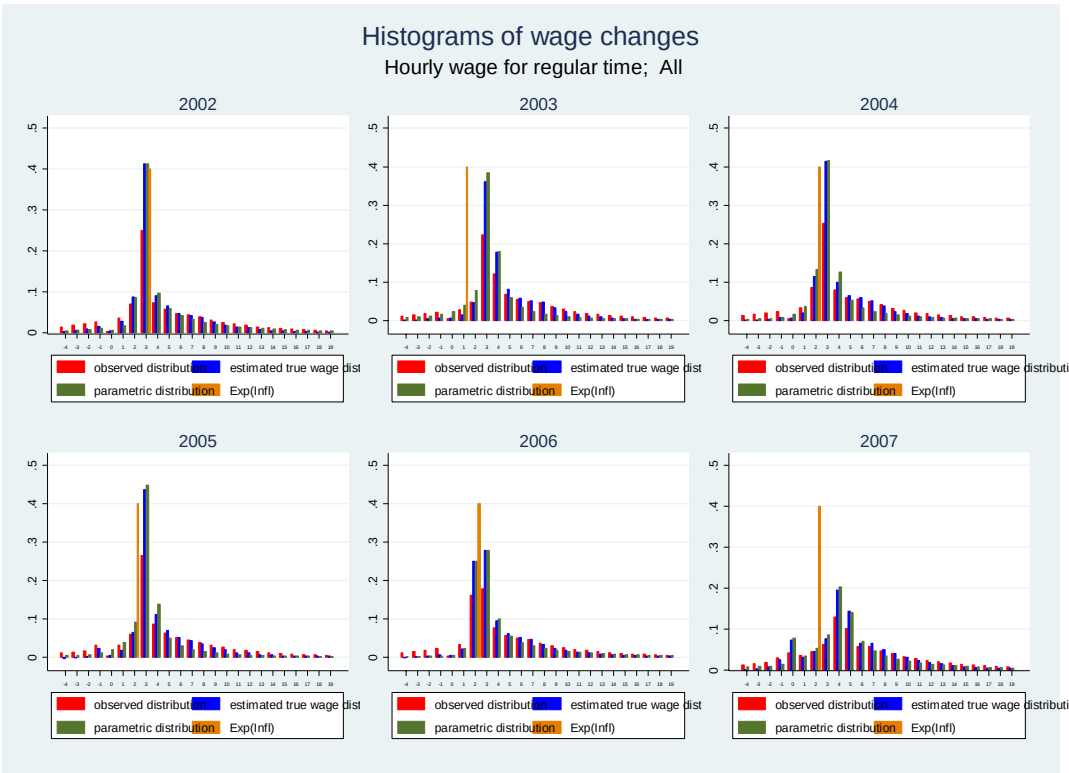


Figure 17. Histograms for observed, estimated true and parametric wage change distributions





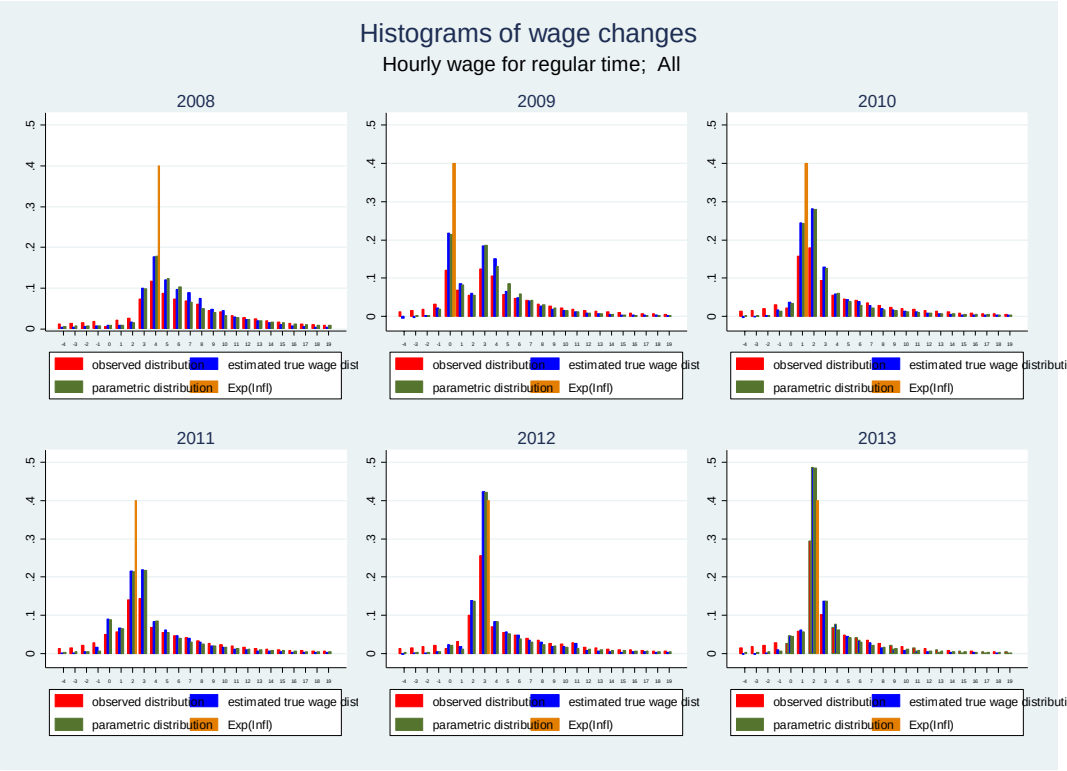


Figure 18. Wage changes centered on inflation and contract wage rise averaged over all years

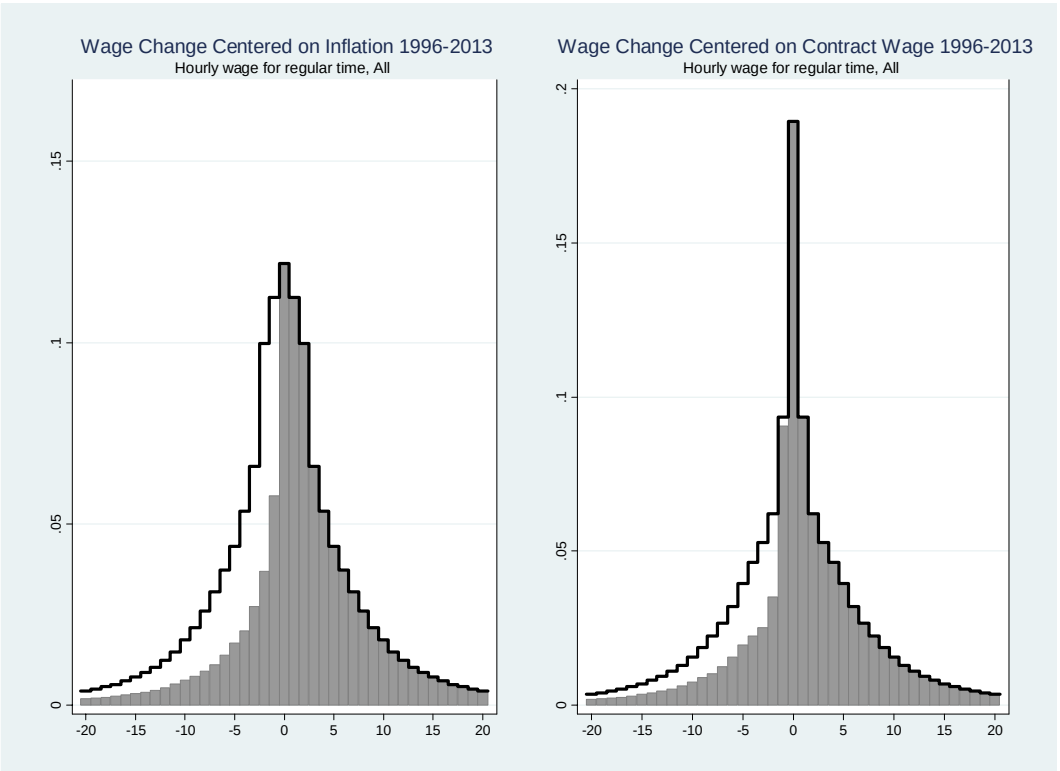


Figure 19. Real wage rigidity

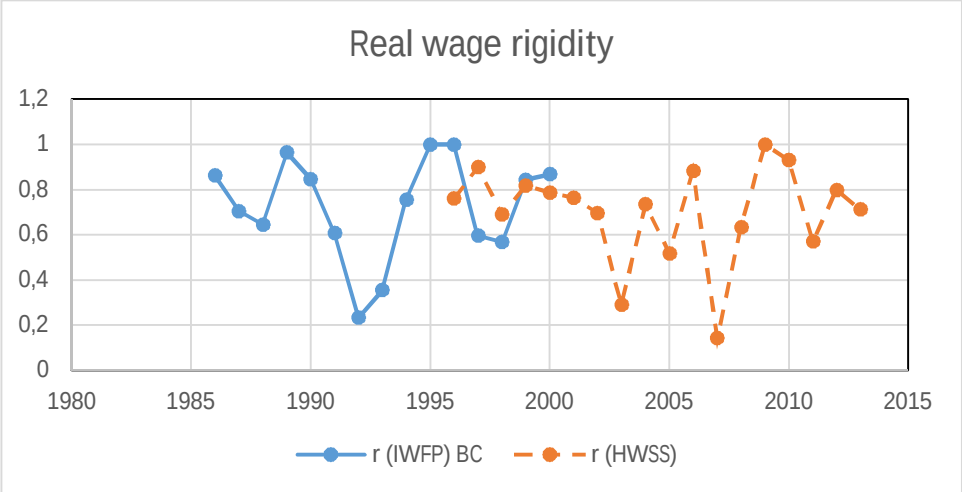


Figure 20. Nominal wage rigidity

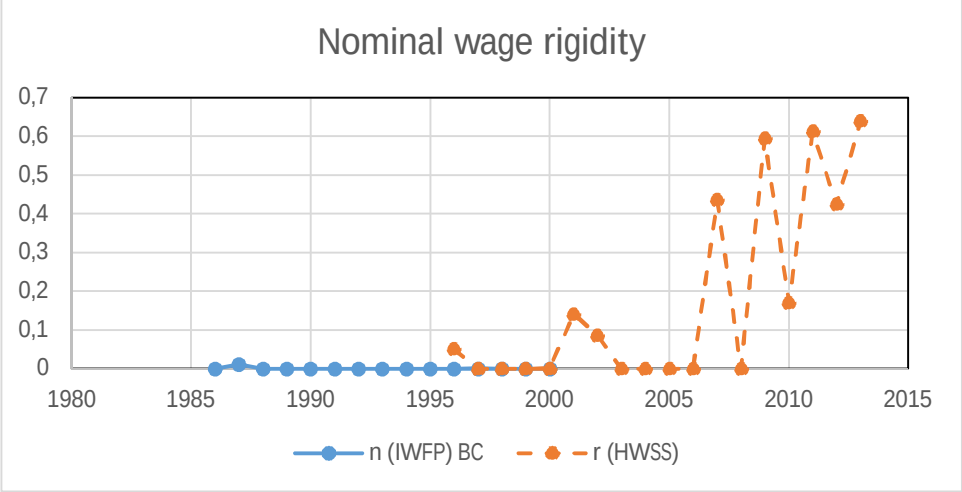


Figure 21. Total rigidity

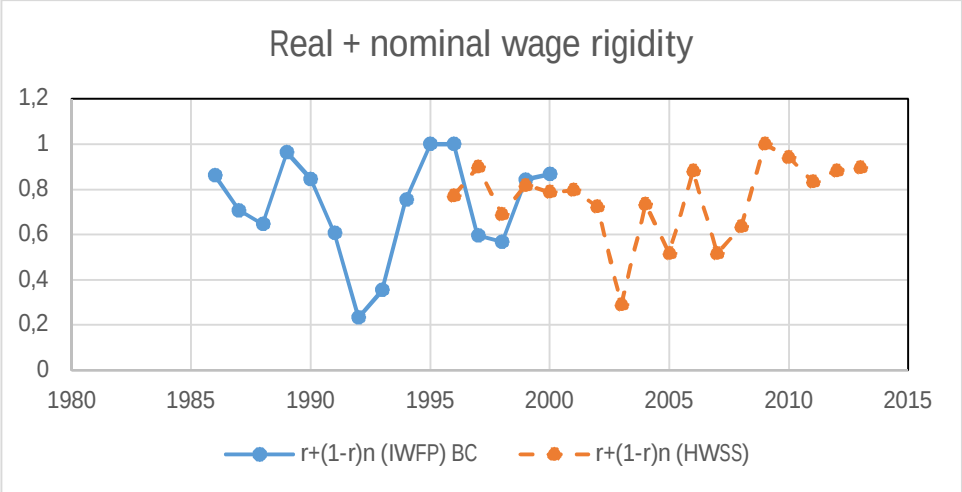


Figure 22. Fraction of workers affected by downward rigidities and the total wage sweep-up effect

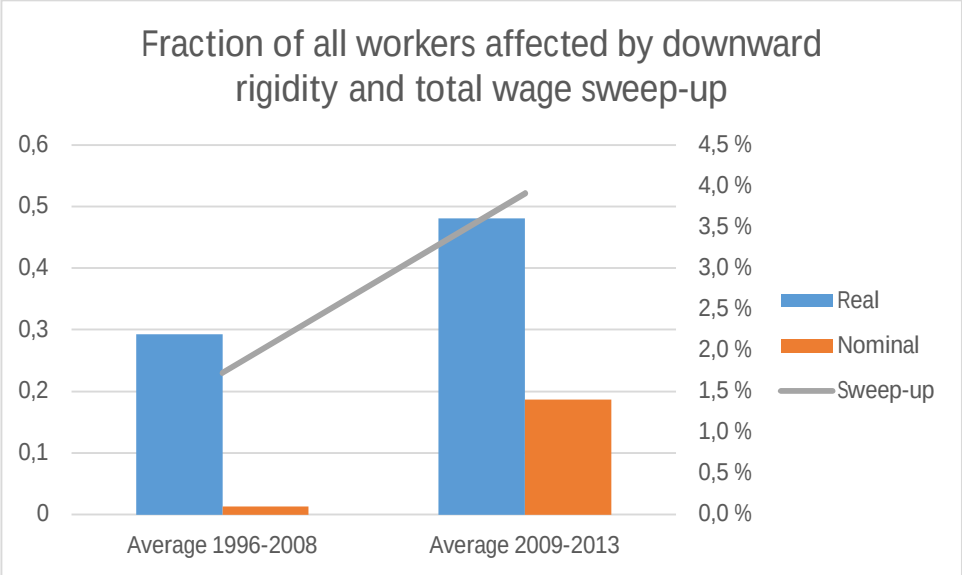


Figure 23. The total wage sweep-up effect annually

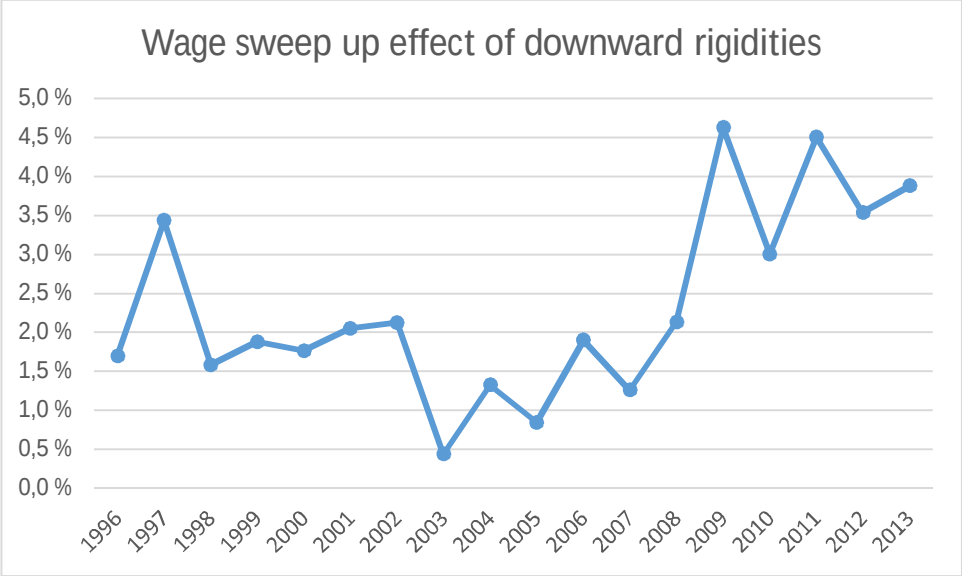
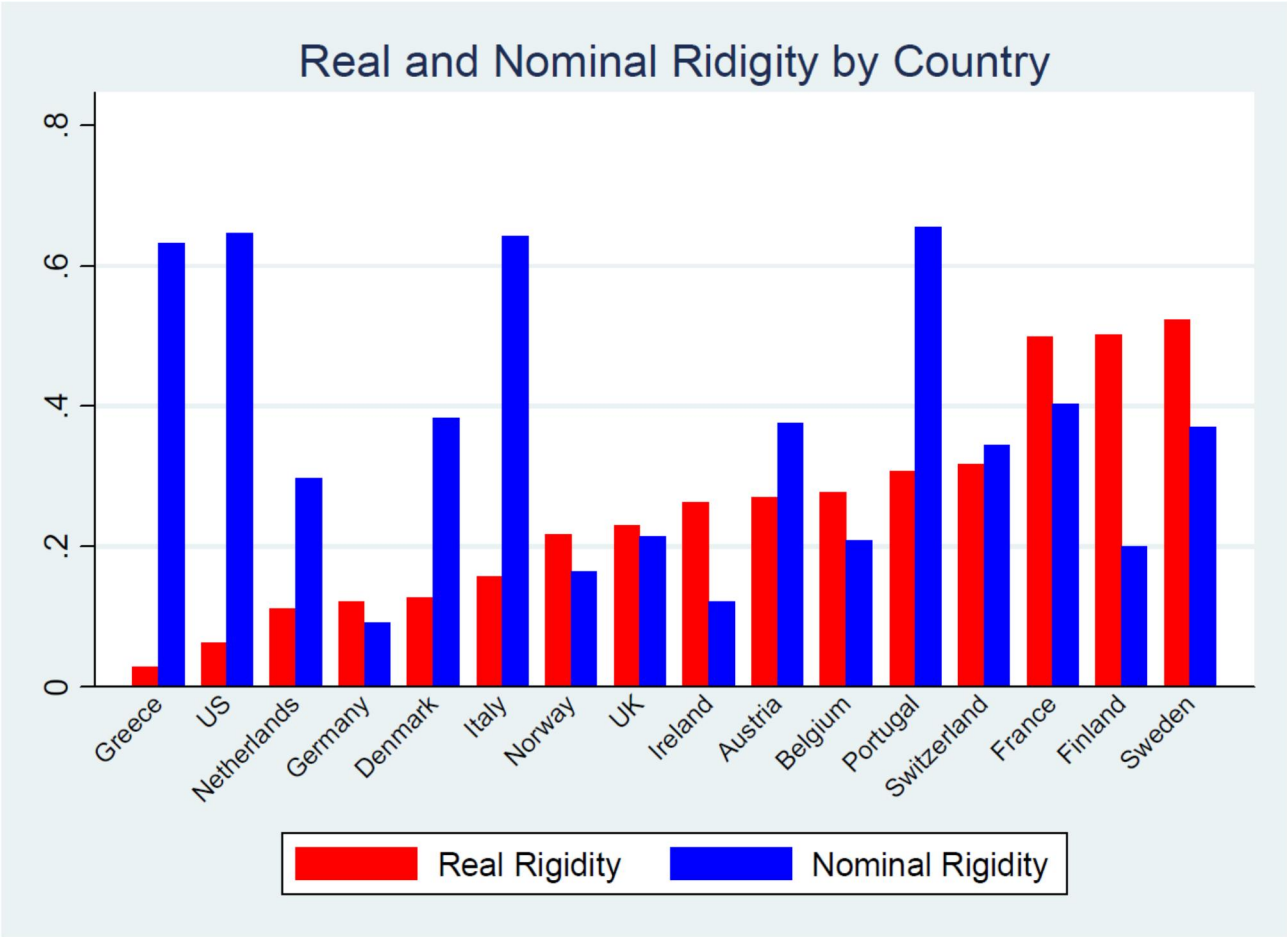


Figure 24. Estimates for average real and nominal wage rigidity for countries in IWFP project



Source: Dickens et.al (2006), Figure 4. These are the MMM estimates of r (the prevalence of downward real wage rigidity) and n (the prevalence of downward nominal wage rigidity), averaged across all dataset-years for each country.

Figure 25. Decomposition of the change in wage bill by Sales status